THE

ELECTRICAL REVIEW.

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THE

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THE ENGINEER BRANCH OF THE ROYAL NAVY.

WE have received a pamphlet, dated November, 1898, which purports to set forth some of the grievances of the Engineer Officers of the Royal Navy. The chief complaint seems to be that in a service where authority should accompany responsibility, the responsible officers of the engine room have not authority over their own men, but must appeal to Officers of the Line. Then, in a service where rank is shown by the uniform a man has to wear, the uniform of the engineer is an inferior one, and generally it is held that there is long standing dissatisfaction in all ranks, and it is plainly hinted that the paucity of the staff would lead to probable disaster in time of action. Now this is not as it should be. If the engineers of the Navy are dissatisfied let them all be summarily discharged, or let these grievances be set right. We cannot afford that the navy should be manned by discontented men, and any cause for dissatisfaction ought to be removed. Pay is alleged to be insufficient, and rank to be unfairly below that of deck officers. Yet it cannot be doubted that the men below deck are in the most hazardous place, and are likewise out of sight of all which makes a post of hazard also a post of interest during a fight. We should like to know that the grievances of the navy will be made right, and we should also like to feel that there are competent men in the navy. It may be urged that the subject we are discussing is more fitted for the *Admiralty Gazette*, but when we consider the manifold uses to which electricity has been turned for almost every purpose on board ship, we feel that naval engineers have a special claim upon our sympathies. With the pamphlet, which, by the way, bears no imprint and no names or signatures, is also sent a report on the *personnel* of the United States navy, detailing somewhat similar grievances, the pay being complained of as inadequate.

No doubt much, if not all, of the trouble with both navies is due to the rapid change from sail to steam, which has ended in making a machine of the battleship, and has made the engineer really of first importance. Engineers could fight a ship—they really do fight the ship. The layman might well ask why there should be any deck officers at all, for the old days of boarding are gone probably for ever. To the engineers below no doubt the deck officers' special privilege is to be either killed off hand or live to be covered with fame and glory, while the engineer remains below either to be parboiled or otherwise brought to an unpleasant and inglorious end or to survive and get to port to be dragged, as it were, in the triumphal procession of the line officers.

We draw attention to the pamphlet because, as good citizens, we want to see the navy efficient and well manned. We don't like the discussion to turn too much on gold lace or

distinctions of cloth in the uniform, but people not in the services probably do not realise the intensity with which uniformed people look upon millinery, which is the outward and visible sign of rank and standing in the services.

We believe that the Line are inclined to despise the engineer. Why they should do so is not very clear. Admiral Lord Nelson himself could sail a ship, and was *au fait* with all the means and appliances of propulsion in his day, and had he lived to-day would, no doubt, have properly valued the propelling business of the modern ship. A little steam would have saved him many a weary wait in port. Too much importance cannot be attached to the engine department of a modern navy and the multiplicity of details which is included in the term. The country should see to it that if anything is wrong it may at once be set right.

The Blast Furnace as a Source of Power.

We have received a copy of a paper read by Mr. Horace Allen before the South Staffordshire Institute of Iron and Steel Works Managers, upon the Thwaite-Gardner system of utilising blast furnace waste gas. Mr. Allen, who is an experienced metallurgical chemist, goes very thoroughly into the question of the chemical reactions in the blast furnace, and shows that in no furnaces is the gas output so poor that it will not burn satisfactorily in the gas engine. This is a fact which places the blast furnace ahead of the ordinary gas producer, which can readily be so neglected as to produce a gas too poor to use in an engine. He shows the exceedingly uniform composition of the gas, and its constant thermal potential which renders it a safe gas for large cylinders and large power units, the variable nature of other gases being a great hindrance to their use in very large engines. It is pointed out that one cubic foot of blast furnace gas represents 22,372 foot-pounds of work. Yet this gas is being thrown away in large volumes, and even where "utilised" under steam boilers it does not develop one-fourth the power it will develop in the gas engine. The system is at work already at two English ironworks, and others are preparing for it, but Mr. Thwaite has just completed a plant at Berge-Borbec, in Germany, for the manufacture of calcium carbide. The gas engine by Hartley and Petyt is of 180 I.H.P. The gas contains about 31 per cent. of CO, and the engine will run on about 100 cubic feet per I.H.P.-hour, which is equivalent to about 1·3 lbs. of coke charged into the furnace, a result which is remarkable, seeing that the furnace is making iron as usual. It simply proves that the heat utilised in metallurgy is small, and that practically the whole of the fuel is sent to waste, and this immense volume of gas is ready to be utilised to drive tramways, pump mines, haul boats, or light cities. It is remarkable that no blast furnace men joined in the discussion on Mr. Allen's paper, and it would appear that the technical knowledge of many of our ironworks managers is insufficient for them to realise the subject. The pioneer in the matter is Mr. James Riley, who put down the first Thwaite plant at Wishaw, but Mr. Riley always has been head and shoulders above the bulk of the ironmasters, and led them in other economies, such as ammonia recovery. It appears that the Germans have gone into the matter very fully, boldly setting up a large engine and a carbide furnace. If Germany is going to use all her blast furnace gas and save so much of the fuel now used for power purposes, we fear that our iron masters, who are now standing supine, will discover they have made a mistake in not seizing promptly on so obvious and large an economy.

Oxidation and Reduction Chains, and the Influence of Complex Ions on the Electromotive Force.—There is an important paper on this subject in the *Zeitschrift für Physikalische Chemie*, 1898, 26, 193—236, by Rudolph Peters, which is well worthy of careful study. In this paper he gives the results of some experiments which he has recently conducted, and the conclusions which he has been able to draw from them. If a mercury electrode be employed in a mixture of ferrous and ferric salts, a reaction proceeds in accordance with the equation $Hg + Fe \ldots + C_1' = Fe \ldots + Hg\ C_1$. For any concentration the potential is given by the expression $\pi = RT/F \times \log. C_2\, c_3/C_3\, c_2$, where C_2/C_3 is the equilibrium ratio of the ferrous to ferric ions, and c_2, c_3 the actual concentration of these ions. This may be written $\pi = A + 0{\cdot}0575 \log c_3/c_2$, and the value of A may be obtained directly by making $c_3 = c_2$, or by calculation from the E.M.F. at any concentration, and the values so obtained from the E.M.F. of a number of very different mixtures agreed very closely and corresponded with an equilibrium ratio $k = 10^{A10{\cdot}0575} = 10^{7{\cdot}50}$, which is, hence, the ratio of the numbers of ferrous and ferric ions when the solution is in equilibrium with the normal electrode. (Complete or equal dissociation of the two ion salts is assumed in the calculation.) By the addition of potassium chloride, the value of k was diminished, the mean value obtained being $10^{7{\cdot}15}$. In neutral solutions, the potential was found to vary considerably with dilution, but this was not the case in acid solutions or solutions containing potassium chloride. Solutions in a normal sodium nitrate solution gave values almost identical with those in pure water, so that ferric chloride and ferric nitrate are equally dissociated. In the case of mixtures of ferric and ferrous sulphates, the value of k was found to be $10^{6{\cdot}6}$, so that at equal concentrations ferric sulphate gives fewer ferric ions than the chloride. Experiments with chromous and chromic compounds, and with manganous and manganic compounds, gave no quantitative results, as constant values could not be obtained. The Van't Hoff expression employed for the ion chain was, however, found to be at least qualitatively correct. Addition of fluorine ions in all cases raises the reduction potential, and this effect was further examined. The conductivity of mixtures of ion salts with sodium fluoride is less than the sum of the conductivities of the constituents, the difference being greatest with ferric compounds, in which case also it increases with dilution. The ferric salts, therefore, probably form complex compounds with the sodium fluoride, a view further supported by freezing point determinations. By the addition of sodium fluoride to the mixed ion salts the E.M.F. falls greatly; thus, in the case of a mixture of N/10 ferrous and ferric salts the addition of an equal volume of 3 N/10 solution of sodium fluoride caused the E.M.F. to become negative, or decreased the concentration of the ferric ions to 10 of its former amount. A white salt is also precipitated by the fluoride, and the composition was found to be $Na_3\ Fe\ F_6 + \frac{1}{2}\ H_2\ O$. This was proved to be a complex salt in which the iron is present in the anion, as by electrolysis the percentage of iron increased at the anode and decreased at the cathode. It is probable that the reduction of the E.M.F. by addition of sodium fluoride is due to the formation, not only of the slightly dissociated ferric fluoride, but also of this salt.

The Solution of Platinum and Gold in Electrolytes.—There is a paper by Max Margueles in the *Ann. Phys. Chem.* (II), 65, 629, on this subject, in which he describes some interesting experiments. An electromagnet with armature serves as contact breaker to the current from two Daniell cells, and between the terminals of the coil of the magnet an electrolytic cell with gold or platinum electrodes is introduced. With this arrangement the metal can be dissolved in hydrochloric, nitric, or sulphuric acid, or in potassium or sodium hydroxide. The metals always dissolve from the electrode, which is the anode to the battery current. The solution is, however, in some way assisted by the current from the magnet, as neither a constant or intermittent current from the battery alone is capable of effecting solution.

A MECHANICAL SURFACE CONTACT SYSTEM.

There has been abundant activity displayed in devising surface contact systems. They are divided into two classes, one relying on magnetic devices, and the other on mechanical apparatus. Some of the former have been reviewed in these columns; we now purpose to set forth the principal features of a mechanical surface contact system which possesses some interest. It is one invented by Mr. Herbert Allen and Mr. Oliver Peard, and primarily depends upon the wheel of a tramcar depressing the end of a pivoted lever, which raises, through the medium of a rod, a surface contact placed in a box which is bolted to the side of the rail. The contact is then gripped and supported by a special form of collecting device carried under the car; immediately the vehicle has passed, the contact drops back into its seat, which is flush with the roadway. The contact, on engaging with the collecting device, is still further raised by means of the collector, and it is only when the contact is so raised, that it becomes alive. This is claimed to be an important safety factor. A clearer indication of the system is given in fig. 1.

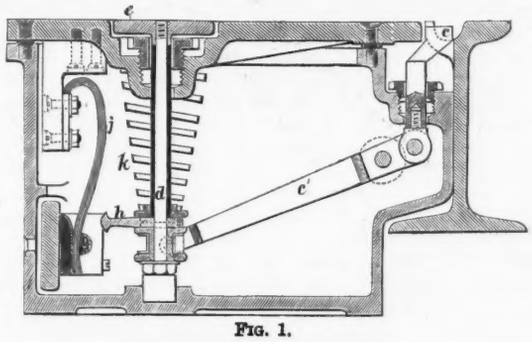

Fig. 1.

c is the end of the pivoted lever placed in the groove of the rail; upon being depressed it operates the lever arm, c', which pushes upwards the spindle, d, on the summit of this being contact plate, e. But the depression of c accomplishes more than merely pushing up the contact above the street level. It will be seen that the spindle, d, carries a projecting arm, indicated by h, and upon the subsequent raising of the contact by the collector, this comes into contact with copper brushes, j, which are in permanent connection with the feeders. It should be mentioned that the operation of d is against the tension of a spring, k, so that when the contact, e, has been released by the car, it is pulled sharply back into its seating.

It is hardly necessary to give minute details of the way in which the various parts of the box are insulated. Fig. 2

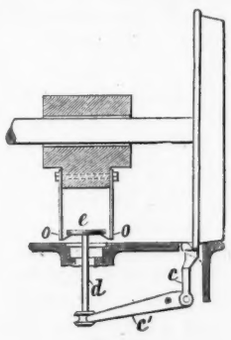

Fig. 2.

demonstrates how the contact is held by the car collectors during the passage over the stud; e simply rests upon plates o, o, thus giving effective connection between the car and the mains.

The inventors claim that it is impossible for the lever to be operated by any other means than the car wheel. In the first place, no other vehicle could possibly operate in the groove of the rail, and, in the second place, it would need a considerable weight to actuate the mechanism; certainly it could not be done by a person using a stick or similar means.

Another, and, perhaps, more important claim is, that in the event of anything going wrong with the simple mechanism of the box, the whole of the inside is so arranged and attached to the lid as to permit of its being removed and replaced by a new interior, if need be, in the course of a few minutes. We need hardly point out that, unlike some other systems, this one permits of the car running in either direction, as one box is not dependent on another for its actuation.

The inventors inform us that, after making careful estimates, they are of the opinion that their contact system could be laid down at a less cost than that of a first class trolley line.

This appears to us to be rather optimistic, but there is no doubt that a simple "box," such as this, could be constructed for a very low figure, and although there is a certain amount of work on the rails, which would no doubt be done in the shops, the expense of forming a good foundation in the centre of the track is obviated.

We are unable to say how this system works, as there is no trial track down at present, but, as a very well-known firm have taken the patent up, we shall hope to do so at some future date.

ELECTRICAL CANAL TRACTION.

IV.

With accumulators the traffic should not exceed 2 to 2½ million tons. Below this the cost diminishes more rapidly than the cost of overhead lines, and especially the cost per ton kilometre is less. Accumulators are the more advantageous as the headway of the boats becomes longer. The cost of a battery for a "barge" is for towing 2,200 francs, and for propulsion 3,600 francs. Though not referred to in the paper under review, we might here allude to the Thwaite-Cawley electrical system. This consists of a rigid system of channel or Z-bars carried by posts along the banks of a canal at a height of 9 or 10 feet. On or against this rail system run the motors which need not weigh above 900 lbs. for a barge of 100 tons at 2½ miles per hour, the necessary adhesion being obtained by allowing the weight of the motor to overhang the wheels which are pressed against the rails by the leverage of such overhanging weight.

As there are two sets of rails the barges on the near side are hauled by motors on the under set of rails, and those on the far side by the upper motor. There is thus no difficulty in boats passing—a difficulty which wastes a deal of time in horse traction or any system of haulage from the bank surface. It is estimated that the ton mile cost will be ·032d. as compared with 0·77d. with horses. So far no practical tests have been made with the system, though some are in preparation, and we hope to describe them in due course.

The detailed experiences in the *Bulletin* before us of the French attempts to mechanically exploit their canals are worthy of every attention in view of the broken down condition of so many of our English canals, a condition into which they have been allowed to fall, or rather have been thrown, wilfully by the neglect of the railways who succeeded in getting a grip upon them and proceeded to kill them in order to put it out of their power to again enter into competition. The formation of a public trust to deal in a whole and broad manner with our canal system would, we doubt not, produce good results. They are in need of repair, of dredging and of connecting up to take throughout the whole country barges of standard size. Steam propulsion has been proved a success on the Leeds and Liverpool canal, and tugs may also be seen at work on the Bridgewater Canal of the Manchester Ship Canal Company, of which latter, though nominally far from flourishing, it can be said that its existence is a standing menace to any further encroachment of the railways upon the public rights, and it is noteworthy that though the Ship Canal "never will get any traffic," the railways of Lancashire seem very anxious to secure branch connecting lines to points along its banks. In France,

Holland, Belgium and America, the canal policy has never been allowed to slacken, and if canals will succeed in Holland and America, where they are frozen up every winter, how much more should they succeed in England, where traffic should be greater and freezing up is a comparatively rare incident, that the ice boat can usually deal with to the extent of getting traffic through, even in really severe weather for England. The present encumbered state of our railroads would be eased by good canals.

We have before us, as we write, the letter of an English railway manager, in which he complains that the line is so congested with traffic that punctuality of certain trains is an impossibility. One would expect such a congested line to pay dividends, but it seems to be a fatality with our lines that though overloaded with traffic at the highest ton-mile charges in the world they cannot pay dividends.

Resuming, however, it would appear that for mechanical traction on canals to succeed there should be some system which will deal with barges as they now exist, and bank haulage seems well adapted for the purpose and free from a good deal of the troubles of the sunk chain. As regards the use of tugs much depends on the possibility of keeping up the banks in good condition to withstand wash. The power to transmit electricity long distances affords a chance for electrical systems to be worked from distant stations. It should not be impossible to make arrangements for supplies of power from towns along a canal, so affording day loads for costly half-worked plant. Mr. Thwaite proposes to employ blast furnace gas power to generate electricity in the trials of his system, and this enormous fund of now wasted energy could be drawn upon all over the country to furnish canal haulage. A great point in barge haulage is the steadiness of the resistance to be overcome, which enables machinery of a given power to be worked at or near its economical load. In every sense canal haulage seems to be peculiarly suitable for electrical systems, even for accumulators, the power required being comparatively small. Though so many of our canal overbridges are small, we think, as a rule, they will be available for the passing of a motor without alteration, though the rails would require to be brought low, and it might be impossible for two motors to pass when under a bridge, though this need not be considered as likely to happen frequently. One would require to be checked for a second or two, while the other proceeded. Canal haulage by horse-power is a cruel practice and puts horses to a good deal of unnecessary suffering. It is also out of date, and may be partly responsible for the ruin of the canals, which was begun by the selfish policy of the railroads.

ELECTROLYTIC CORROSION.

Two recent surveys of the electrical condition of pipes and other metallic structures buried in the ground in the neighbourhood of electrical street railways, serve to direct attention to the very serious, if not alarming, consequences which may sometimes result from the unrestricted use of the ground return over considerable periods.

One of these surveys has been carried out in the borough of Manhattan by Mr. A. A. Knudson, who has given the result of his investigations in a paper read before the American Institute of Electrical Engineers, New York, October 26th, 1898.* The other has been carried out at Dayton, Ohio, by Mr. Harold P. Brown, who read a paper on the subject before the American Society of Municipal Improvement, at Washington, October 28th, 1898.†

From Mr. Knudson's paper we take a few of the more important results and conclusions. In the first place it is important to note that his tests have shown that an open conduit system, or one in which an insulated metallic return is used, effectually confines the current to the conductors provided for it. For this reason, he says, it is preferable to the ordinary ground, especially in large cities where the space below the streets is so largely occupied with lines of iron pipes, more or less subject to electrolytic corrosion.

Differences of potential between the rails, and gas and water pipes, were measured at numerous points all over the area surveyed. The distribution of potential in the network of pipes was found to be extremely erratic, no doubt owing to the superimposed effects of several electric railways in the same neighbourhood. In a straight line of electric railway with a power station at one end we expect to find the pipes to be positive to the rails for some distance from the station. Then the potential difference changes sign and the pipes remain negative to the rails right out to the terminus. Mr. Knudson, however, found frequent reversals of the E.M.F. between pipes and rails along a short section of track.

The corrosive effect of the leakage currents on the rails themselves may not be of so much importance as the destruction of gas and water pipes, since rails can be more easily replaced. But that the former is by no means a negligible quantity we learn from the following interesting test described in Mr. Knudson's paper. About a year ago he measured the difference of potential between the pipes and the rails at a terminus of one of the lines, and found that it amounted to 10 volts, the rails being positive to the pipes. A few days before reading his paper he again visited this locality, and found workmen engaged in removing the rails. Seizing this opportunity for estimating the amount of corrosion of the rails, he took an impression on paper of the exact size and shape of the end of one of the four rails, the ends of the other rails being in just about the same condition. Fig. 1 exhibits the difference in size and shape of the rail when new and when in its present condition. The irregular curved line in the plan and the thick black line in the end section, showing the reduced form of the rail placed inside the original outlines. It is evident that a large amount of metal has been removed from the rails by electrolysis. The original size of the rails was furnished by the company supplying the rails, they being about 70 lbs. to the yard. Furthermore, the bottom sides of all these rails were cut by the current down to knife edges for several feet back from the ends. The edges were irregular in shape and somewhat jagged in appearance.

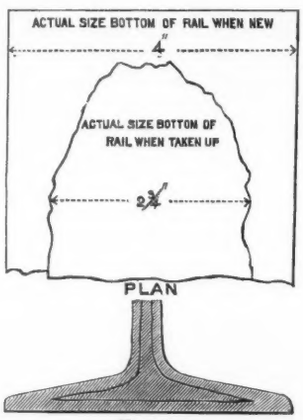

Fig. 1.

Another feature of interest was the condition of the cross bars or tie rods which keep the rails in position. These bars, which were originally 1½ inches wide by ⅜ inch thick, were nearly all so eaten away that the middle portion was missing, the ends protruding from the rails at from 6 inches to 12 inches.

One of the most important, and possibly alarming discoveries made by Mr. Knudson in the course of his survey, was the existence of a current flowing from the attachments of the cables of the Brooklyn suspension bridge to earth. The ends of the main cables of this bridge are connected by screw couplings to heavy steel bars or links which pass down with a graceful curve through solid stone masonry to the anchor plates, to which they are secured by heavy steel bolts passing through eyes at the ends. The anchor plates, somewhat oblong in shape, consist each of a single plate of cast-iron weighing 23 tons.

These anchor plates being thus in metallic connection with the main structure of the bridge, it was sufficient to connect one terminal of the galvanometer anywhere to this structure.

* See also *Western Electrician*, November 5th, 1898, p. 254.
† See also *Street Railway Review*, p. 817, 1898.

The other terminal of the galvanometer required a good connection to earth in the neighbourhood of the attachment being tested. This was found in the cable of the cable railway. Tests made at both ends of the bridge showed that a current was flowing from the cable attachments to earth at both ends; the difference of potential amounting in some cases to 2¾ volts. Now this voltage has been shown to be quite sufficient to cause electrolytic corrosion, if other conditions are favourable. The presence of dampness and decomposable salts, such as chloride of sodium and carbonate of sodium in the ground surrounding the metal from which the current is flowing is generally considered to be a necessary condition of electrolytic corrosion. If this is so, there appears to be little risk of dangerous corrosion of the anchorages of the Brooklyn Bridge, for these anchors are surrounded by a mass of stone and concrete, which the engineers consider would effectually exclude damp, and which contain no electrolyte such as would favour electrolysis.

If this is so, so much the better for the safety of the bridge; but we are inclined to think that a transfer of metal from anchors to the stone or concrete might take place in the course of years, without the most favourable conditions being present. The electric current has a great tendency to carry metallic ions across breaks in the continuity of the conductor by processes which are not strictly included under electrolysis. We have, for instance, the transference of carbon particles across the electric arc, and the well-known phenomena of electric osmose. We should not be surprised to learn that a metallic deposit would be found on the stone and concrete opposite the anchors of the bridge, if they should be examined some years hence. It is at least a question on which it would be dangerous to dogmatise, on theoretical grounds, or even upon the present state of our experimental knowledge.

The survey carried out by Mr. Harold P. Brown is one of the most important contributions that has been made to our experimental knowledge of this vital defect in the practical working of electric railways. The investigations were made in a thoroughly scientific manner; tests of P.D. between rails and pipes being made over the whole area, and pipes affected by corrosion being tested by chemical analysis and by the mechanical testing machine to determine their loss of strength.

Dayton, Ohio, is a city with a population of about 90,000 inhabitants, and possesses fully 80 miles of electric roads. Electrically considered, it is divided into four parts by various rivers which meet and flow through it. Practically 90 per cent. of the entire current from the business portion of the city crosses a river on one 12-inch and one 10-inch water pipe, one 8-inch gas pipe, and one 10-inch natural gas pipe. The two main power houses are about a quarter mile apart on the west side of the Miami river. A third, but smaller power house, is on the east side of the river. Two other roads have their terminals in Dayton, but their power houses are elsewhere. On the map, fig. 2, the numbers marked + show the pipe positive to the rail, and those marked − show the pipe negative to the rail.

Fifteen excavations were made, and the measurements repeated on the pipes themselves. These excavations are marked on the map with a square. A careful examination was made of the physical condition of the pipes, and chemical analyses were made of samples of soil, and the metals of pipes and incrustations upon them.

The electrical tests showed that the pipes, in the business part of the city, one and a half to two miles from their power houses were positive to the rails, and therefore subject to electrolytic corrosion. The highest readings in this part of the city were 4½ volts. Near the power house on the west side of the river, the pipes were 9 volts positive to the rails, and the danger district extended about three-quarters of a mile to the west. It was at once noticed that the danger district was extremely large, and this was verified by the records of the Water Board, which showed a large number of service pipe renewals.

Cast-iron pipes are not usually considered susceptible to electrolytic corrosion, but Mr. Brown found that this was not so in Dayton. The tar coating on the pipes appeared to be no protection whatever, and the surface of the pipe in the danger district was found to be changed to a soft black material resembling graphite, and easily cut with a knife. This material is such an excellent conductor that instead of checking it tends to increase the action by reducing the resistance of the path through which the current must flow in order to reach the rail. Moreover, the stones and peebles near the pipes are actually electroplated with the metal of the pipe, whether iron or lead. This condition has not, as far as Mr. Brown knows, ever before been reported.

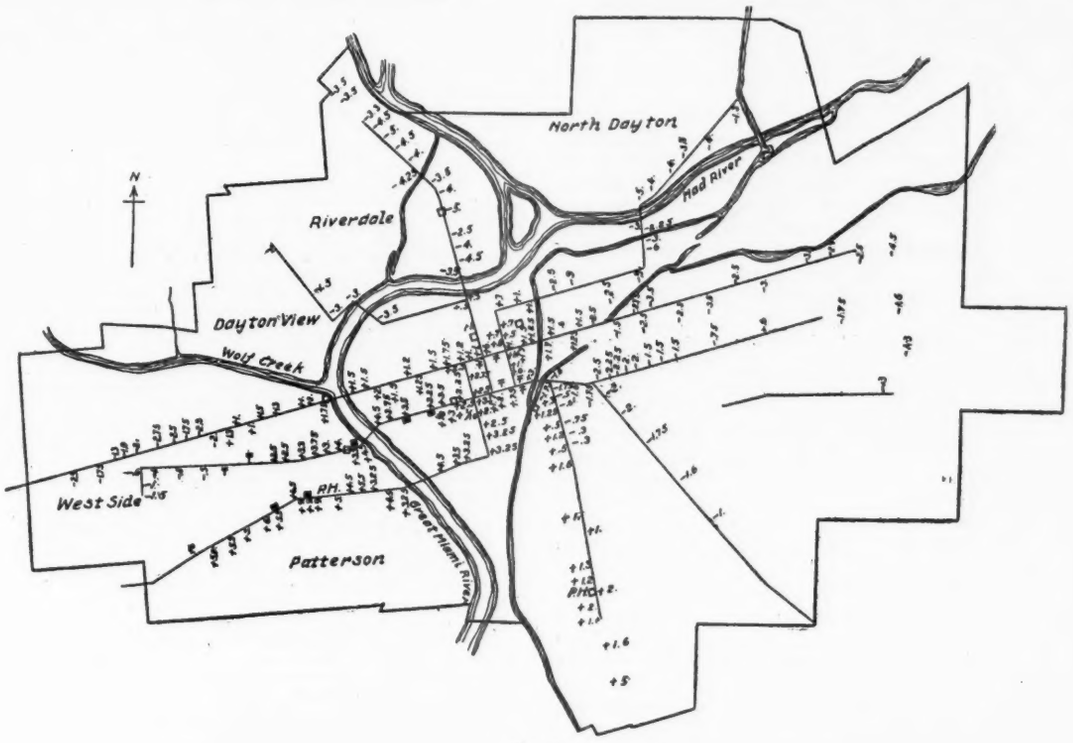

Fig. 2.

To make certain that the corrosion observed was really due to electrolysis, a section was cut from a pipe in the danger area (Fifth Street), and a section from a similar pipe in exactly the same kind of soil, in a part of the city (Logan Street) where there was absolutely no trace of an electrical current. The Logan Street pipe had been put down 24 years ago, while the Fifth Street pipe had been put down 10 years ago, and had been exposed for four years to electrolysis.

The chemical analyses of the two pipes were nearly identical, and were as follows:—

	Logan Street pipe.	Fifth Street pipe.
Phosphorus	·789 per cent.	·800 per cent.
Sulphur	·073 per cent.	·057 per cent.
Silicon	2·270 per cent.	2·500 per cent.
Iron	not det.	not det.
Carbon graphitic ...	3·43 per cent.	2·88 per cent.

The samples of the incrustation of the Fifth Street pipe analysed as follows:—

Phosphorus	1·821 per cent.
Sulphur	none.
Silicon	not det.
Iron	33·43 per cent.
Carbon combined and carbon graphitic ...	7·12 per cent.

This analysis showed that the percentage of iron was greatly diminished, while the percentage of carbon was more than doubled.

Careful investigation showed that the carbon was merely the amount originally in the pipe, the carbon being left, while a large portion of the iron had been carried away.

The chemical analysis of the soil showed that the solvent was produced electrically from carbonate of sodium and chloride of sodium in the soil. Neither of these by itself, in the small proportion shown by the analysis, would injure a cast-iron pipe covered with tar, though, as is well known, a strong solution of chloride of sodium (common salt) will rust wrought-iron.

But the presence of even 0·01 per cent. reduces the electrical resistance of the iron and the passage of the current decomposes those salts and forms hydrochloric acid, which dissolves the metals.

Having thus determined the cause of the trouble, it remained to fix its extent. Fifteen excavations were made in different parts of the city to determine how much electrical pressure is required to seriously injure the cast-iron. A pressure of 3 volts and less is found to cause a graphitic coating not exceeding $\frac{1}{32}$ inch in depth. The iron seems to be uninjured. From 3 to 4½ volts the thickness of the layer is increased in a ratio depending upon length of time during which the pipe has been exposed.

To determine what percentage of mechanical injury has been sustained by the pipes, it was intended to compare the hydrostatic pressures required to rupture the Logan Street and the Fifth Street pipes, but defects in the apparatus employed prevented a fair test.

The Fifth Street pipe at 150 lbs. pressure leaked through the corroded spots, while the other pipe was able to stand 300 lbs. pressure. Test bars were cut from the best portions of both pipes and broken on a Riehle testing machine. The average transverse strength of the Logan Street pipe was 1,800 lbs. per square inch, as against 1,085 to the other.

The tensile strengths were respectively 16,000 and 11,425 lbs., and the deflections were 0·25 and 0 20 inch. Four years of electrolysis had robbed the Fifth Street pipe of about 30 per cent. of its transverse strength and about 45 per cent. of its tensile strength and had caused it to leak at 150 lbs. pressure.

Tests of the resistance of the rail joints of the Dayton line showed that electrically they were extremely bad; in some rails no current at all flowed.

Mr. Brown winds up his able report by recommendations for the reduction of the danger area. He recommends the use of wooden instead of metal pipes, or the intercalation of wooden sections in the lines of metal piping. In the danger area he would connect the sections between the wooden pipes by pilot wires to the central office, where tests could at any time be made. If any of the metallic sections were found to be still positive, these should be further sub-divided by sections of wooden pipe.

These reports show that electrolytic corrosion in overhead electric railways with ground returns may, in the course of a few years, do very serious damage to piping or other underground metallic structures, even with P.Ds. between pipes and rails as low as 2 to 3 volts. But the remedy is in the hands of the electrical engineer. With a comparatively small number of insulated return cables, it is quite possible to keep the voltage between rails and ground less than the dangerous amount. It is only through the indifference or carelessness of the authorities that such damage to neighbouring property is permitted.

STEAM ENGINE GOVERNORS.*

By JOHN DAVIDSON.

(*Continued from page* 891.)

In automatic expansion engines, where the governor has to drive the cylinder steam distribution valve, the friction, &c., to be overcome is often very considerable, and powerful shaft governors have to be used, so that this friction and weight of valve, &c., cannot have a disturbing effect of any note upon the governing of the engine.

As the engine valve really becomes part of the governing mechanism in this case it should receive the first attention. In designing a throttle governor, no one would think of putting an unbalanced slide valve with a great pressure of steam behind it, to throttle the steam, an arrangement which would require an enormously powerful governor to move it, and work in any way satisfactorily, but would fit it with an almost frictionless valve, and a small governor will do the work with ease.

So ought it to be as near as is practical with the shaft governor. The valve should be made as free as possible, consistent with the necessity of keeping it steam tight. Solid piston valves, perhaps, make the simplest valve of this description, but they do not keep steam tight long enough. Slide valves balanced properly are also a good step in this direction. Anyway, fitting unbalanced valves and then designing a tremendous governor and gear to drive them, is working in the wrong direction entirely, although often done, governors of all kinds being designed, so that the valve resistance shall have little tendency (and mostly at the expense of great friction) to open and shut the governor each revolution of the engine.

The valve gear of unbalanced slide valves and such like, requires to be of heavy design which is needless, and the effects of inertia then come into play if the engine goes at any speed, and this again adds to the work of the governor. Now the valve friction, and these extra resistances, which have to be overcome by the governor, create in the governor itself, other resistances at the joints, &c., and this has a serious effect upon the sensitiveness of the governor, making it sluggish in responding to a change in speed, and making it far more liable to soon get out of order and give trouble.

Balanced valves need only gears of light construction to work them, and smaller spindles at the staffing boxes, which again reduces friction. If the valve and gear be so designed, a much less powerful shaft governor can be used, and yet have sufficient margin of power to effect a change quickly. This question of weight and resistances of valves and gears is a most important one, and had it received more attention, would very likely have led to a much more extensive use of the variable expansion shaft governor, the fate of which, in many instances, has been caused by valves and gears being made many times too heavy, and the governors being expected to move valves against ridiculous pressures.

As I have now considered some of the ways in which the governor of a steam engine acts, and also some of the advantages and disadvantages of the two types of governing, I will put before you a few examples from actual practice, showing the way the mechanism is arranged to effect the change in pressure or rate of expansion of the steam.

When the throttle governor is applied to an engine the most common method of arranging it is to combine the governing mechanism and valve together and drive the revolving portion by a belt, rope, gearing, or chain from the engine shaft. By this arrangement the governor can be run at any desired speed by suitably designing the gearing, and a comparatively small governor can be used. This makes a very compact governor gear, but in all cases where a belt or rope, &c., is used, a safety gear should be provided, in case of the belt breaking, to shut off the throttle valve, which otherwise means the engine would run away directly this occurred.

A few well-known and simple makes of this type of governor are the Acme, Proell, and the Pickering.

Fig. 4 shows a sectional view of Lindley's patent Acme governor, Messrs. Browett, Lindley & Co., Limited, having kindly supplied me with a drawing of the same. As will be seen, the weights, W, in this governor consist of two hemispherical masses with lugs cast on the bottom side to receive the pins, A, on which the weights swivel when they open out, being held together by two springs at S, one on either side. The weights are connected to the crosshead, C, by means of the links, L, the crosshead being connected to the throttle valve spindle, V, by the nuts, N. The weights are revolved by the belt pulley through the bevel gearing shown, the wheel, B, having lugs

* Paper read before the Salford Science Students' Association at the Royal Technical Institute, Salford.

cast on it to receive the lugs on the weights, these weights, &c., revolving on a steel tube, through the middle of which passes the throttle valve spindle. As the speed increases the weights fly out,

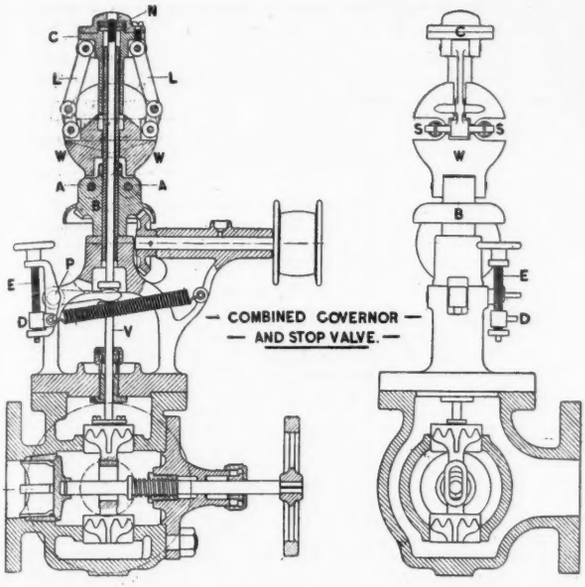

Fig. 4.

due to centrifugal force, and they draw the crosshead, C, downwards through the links, L, thus closing the valve and throttling the steam.

A very handy speeding arrangement is also fitted to these governors, so that the speed can be varied very considerably, even while the engine is running. Pivoted at P is a T-lever, one end, which is forked, working in a sleeve on the valve spindle, the other two ends being bent to receive a screw, E, upon which works the nut, D. A spring is stretched across in a horizontal position from a pin on the right-hand side of the governor stand, and fastened to the nut, D. You will readily see that, in the position shown, the tension of the spring will help to open the throttle valve, or assist the main governor springs to keep the weights closed, and so increase the speed of the engine. If the nut, D, be moved to the other end of the screw, which can be turned by the small wheel provided for the purpose, the spring would tend to shut the throttle valve and decrease the speed, while, if it is put in the centre position, the effect of the speeder spring is *nil*. By moving the nut to any intermediate position on either side, you can regulate the speed to a nicety anywhere within about 15 per cent. of the mean speed. This makes a very neat and compact form of governor, and, judging by the thousands now in use, it must do its work efficiently.

Fig. 5 shows a sectional view of the Proell governor combined with a

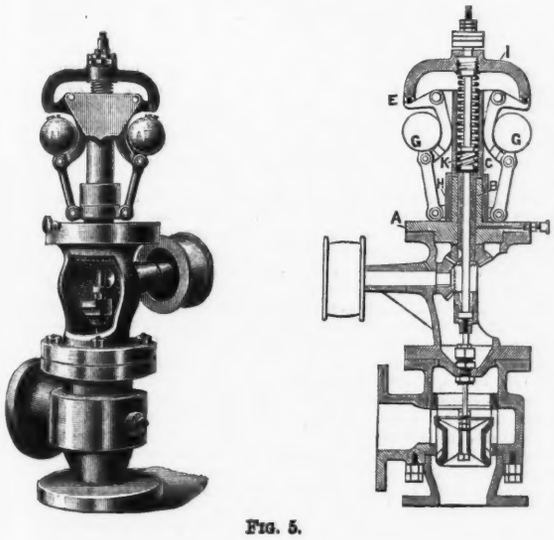

Fig. 5.

throttle valve, the makers of this governor being Messrs. Isaac Storey and Sons, of Manchester, to whom I am indebted for drawings and particulars. This scientifically designed governor is used in many ways for regulating purposes, being fitted to Corliss, Meyer, Ryder, and all kinds of releasing gears, as well as for throttle governors, as shown in the figure, which I will now describe.

A is a flange fastened to the governor stand, having a sleeve, B, in which is fitted the hollow spindle, C. At the top of this spindle lugs are cast, to receive pins, from which are suspended the two bell crank levers, E. From the bottom end of these levers are hung the two inverted pendulums, G, which, at their bottom end, are attached to a movable sleeve, H. The top ends of the levers, E, engage with knife edges on the ends of the crossbridge, I. To this crossbridge is attached one end of the spring, the other end being fastened by a suitable holder to the spindle, C, at K, the spring acting in tension. As the weights fly out, the bridge piece is lifted, and with it the valve spindle, which closes the valve to throttle the steam.

As the balls move out, they do so almost in a horizontal line, and an almost isochronous governor is the result, and also gravity has no disturbing effect upon the weights, as they are not raised or lowered. This is a very powerful and sensitive governor.

Fig. 6 represents the Pickering governor, Messrs. Evans & Sons

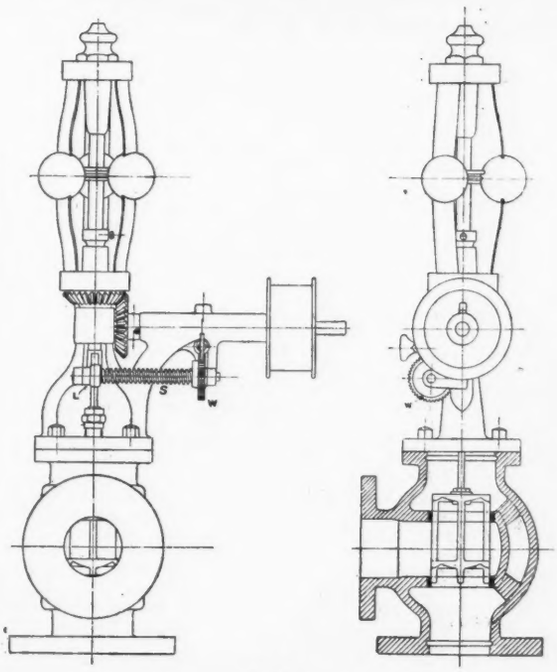

Fig. 6.

Wolverhampton, the makers, having kindly supplied me with the drawing and particulars. This well-known governor is somewhat different to the last described, owing to the fact that the three weights or balls are suspended on thin strips of steel, which does away with the necessity of joints, and their consequent friction, this being the principal feature in the design. These strips bend as the balls move out, and take the place of springs, as well as the joints in the ordinary form of governor. The action of the governor is as follows:—As the balls move out, due to speed increasing, the strips bend, and the ends are drawn closer together, and as the bottom ends of the strips cannot move upwards, being fixed to revolve in one vertical position, the top ends draw the crosshead, and with it the throttle valve spindle downwards, closing the throttle valve, and reducing the pressure.

A single speeder gear is also fitted to this governor to vary the speed of the engine while running if necessary. A small worm, which can be turned by the thumb screw shown, is geared with a worm wheel, W, to which is fastened the speeder spring, S, the other end of the spring being attached to the lever, L, at its fulcrum. If the spring is twisted either way by turning the worm wheel, it is put in torsion, and will tend through the lever, L, to open or close the throttle valve, and vary the speed accordingly.

The three governors just described are suitable for both slow or quick revolution engines, but a very good arrangement and a more reliable one for quick revolution engines, is to fix the weights, &c., to the crankshaft of the engine, and so save any driving belts or gears, the governing mechanism being coupled to the throttle valve, which is placed close to the cylinder, by a link and rod. An arrangement similar to this is adopted by most of the principal builders of quick revolution engines, when throttle governing is used.

(To be continued.)

AN IMPERIAL CABLE SERVICE.

From a recent Ottawa telegram sent by the *Times* correspondent we learn that—

"It is now announced on authority that the Dominion has offered

to contribute an equal share with the Imperial Government of the cost of the construction of the Pacific cable, the joint obligation not to exceed five-ninths of the whole cost. The Australasian colonies have undertaken to contribute the balance."

From this it will be seen that it now lies solely with the Home Government to take action.

The following is the text of a letter to the Right Honourable Joseph Chamberlain on the subject of a State-owned system of submarine cables which has been written by Sir Sandford Fleming, and which we reproduce in full as published in the Toronto *Globe*:—

OTTAWA, *October 28th*, 1898.

The Right Honourable Joseph Chamberlain, Secretary of State for the Colonies:—

Sir,—I had the honour, on December 28th of last year, to address Sir Wilfrid Laurier respecting the proposal to establish a State-owned Pacific cable. Circumstances have since arisen which impel me to ask permission to address you on the subject of a State-owned system of cables for the British Empire.

The paper which follows discusses the subject on its merits. I venture to think that the arguments adduced make it clear that such a service is extremely desirable, and is fast becoming a necessity. The telegraph is an essential ally of commerce, and is indispensable to the full and satisfactory development of trade and shipping. The trans-Pacific steamship lines which have been established are heavily handicapped by the absence of any direct means of telegraphy between the ports with which trade is carried on. The Pacific cable would serve the purposes of trade between Australasia and Canada, but these countries are debarred from establishing independent telegraphic connection with Hong Kong, the terminal port of one of the steamship lines. Under an agreement dated October 28th, 1893, the Eastern Extension Telegraph Company strengthened its monopoly by having Canada and the southern Colonies telegraphically excluded from Hong Kong and forbidden to lay or assist in laying any new cable to that port for a period which does not expire until 20 years from the present date.

There remains only one way of gaining telegraphic connection with Hong Kong freed from exacting charges, and that is through the Home Government. In granting to the Eastern Extension Company exclusive privileges, Lord Ripon, then Colonial Secretary, reserved to Her Majesty's Government the option to take possession of the cable between Singapore, Labuan and Hong Kong by giving 12 months' notice and paying the company £300,000.

My letter of December last to Sir Wilfrid Laurier (copy enclosed) sets forth the position and the attitude to Canada and the Australasian colonies of the Eastern Extension Telegraph Company. The proposal submitted in the following paper would undoubtedly interfere with the rich monopoly which that company enjoys, and, to some extent and for some time, diminish its profits; but I venture to hold that no private company, however rich and influential, should be allowed to stand in the way when great Imperial interests are at stake. It must be borne in mind, too, that telegraphy is one of the most astonishing results of science, and that the facilities which it offers, if not shackled by hindrances, may be rendered of greater and greater value to the human race.

The advantages of cable connections and low charges increase with distance in an accelerating ratio. It is impossible, therefore, to set a limit to the commercial, social and political benefits which would result to the empire from a State-controlled cable service reaching every British possession. In the following remarks I have pointed out that the Pacific cable, established as now proposed, will prove to be the key to such a service, and practically its forerunner.

I have the honour to be, sir, your obedient servant,

SANDFORD FLEMING.

EMPIRE CABLE SERVICE.

Following is the paper above referred to:—The action recently taken in London in adopting the principle of cheap Imperial postage suggests that the time has arrived when the expediency of establishing a complete telegraph cable system throughout the empire may be considered on its merits. The advantages which will inevitably follow the adoption of a universal penny postage appear to be generally recognised, and I venture to think the public mind will be prepared to entertain favourably another proposal not less important. It is not necessary in the least to undervalue cheap postage or detract from its immense importance in order to show that a cheap telegraph service on a comprehensive scale is easily attainable, and that it would prove an effective means of speedy communication for an empire such as ours.

The transmission of letters have always been a function of the Government; indeed, it has been wisely held throughout the civilised world that the postal service should be controlled by the State. The electric telegraph is a comparatively modern introduction. In the mother country private companies were the first to establish lines of telegraph, but in 1868 it was found to be in the public interest to have them taken over by the State and placed under the Post Office Department.

A Committee of Inquiry had reported to Parliament:—"That the telegraph service as managed by the companies, (1) maintained excessive charges; (2) occasioned frequent and vexatious delays in the transmission of messages, and inaccuracies in sending them; (3) left a large number of important towns and districts wholly unprovided for; and (4) placed special difficulties in the way of that newspaper press which had in the interests of the public a claim, so just and so obvious, to special facilities." The transfer was effected in 1870. Changes and improvements were immediately made; the telegraph service, previously confined to lines connecting great cities where business was most lucrative, was extended to many towns and districts previously neglected, and, notwithstanding the fact that the charges on messages were greatly reduced, the business developed to such an extent that the receipts progressively increased. Before the transfer it cost about 6s. to send an ordinary message from London to Scotland or Ireland. The rate was reduced to 1s., and subsequently to 6d. (the rate at present charged), and for that sum a telegram can be sent from any one station to any other station within the limits of the United Kingdom, without regard to distance.

It was early discovered by every country in Europe that so efficient a servant to trade and commerce, so important an aid to the State itself, should become a national institution. France, Austria, Prussia, Russia, Sardinia, Italy, Spain, Portugal, and Belgium each established a State telegraph system, and, as in Great Britain, experience has shown that they have done this, not only with advantage to the various administrative necessities, but with benefit to the public at large.

Such being the unanimous conclusion, is not the application of the principle of State ownership on a larger scale than hitherto attempted a fit subject for inquiry? Is it not desirable and expedient that the whole British Empire should have a State-controlled cable system?

INEVITABLE DEVELOPMENT.

The conditions of the empire are totally different to what they were some years back. When Her Majesty ascended the throne there was not a single mile of electric telegraph anywhere. There was not an iron ship of any class afloat, and mail steamships were practically unknown. From that period the conditions have been continually changing, and the process of growth and development still goes on. True, change has met with resistance from individuals and companies and classes; but resist it who may, the law of development follows its steady course, and continually makes demands on science and skill to meet the ever-changing conditions. We are living in an age of transformation; the spirit of discovery and enterprise, of invention and achievement, has extended and expanded the British Empire, from the small islands on the coast of Europe to new territories, continental in extent, in both hemispheres. The development of the mercantile marine has carried the flag of our country over every mile of sea to meridians far distant from the mother land. In these distant territories communities have established themselves under the protection of that flag. They have drawn riches from the forest, the soil, and the mine. They have caused noble cities to spring up, rivalling in the splendour of their streets and buildings the finest cities of the old world. These young nations, full of hope and vigour, have made progress in every direction; they are imbued with lofty aspirations, and their most ardent desire is to give their energy and strength to the building up of a greater British Empire on the firm foundation of common interest and common sentiment.

At an earlier period in the world's history it would have been difficult to conceive the possibility of any lasting political union between countries so widely separated by intervening seas. The problem is, however, being solved, not by old methods, but by the application of wise principles of government, aided in a wonderful way by the highest resources of modern science. Steam has made the separating oceans no longer barriers, but rather the medium of union. Electricity has furnished the means by which the British people in all parts of the globe may exchange thought as freely as those within speaking distance. These twin agencies of civilisation are pregnant with stupendous possibilities. Already the one, as the prime factor in sea carriage, has rendered universal penny postage possible. The other has made it equally possible to bring the British people, so widely sundered geographically, within the same neighbourhood telegraphically.

PENNY POSTAGE.

Imperial penny postage will have far-reaching consequences; it is undoubtedly a great onward movement in the career of civilisation, and in the development of wider national sympathy and sentiment. But great as are the benefits to follow the adoption of universal cheap postage, the first result, and not the least, will be to make plain that a postal service, however cheap and comprehensive, is in itself insufficent for the increasing daily needs of the now widely distributed British peoples. It will be seen that in addition to an ocean penny postal service, the circumstances of our world-empire demand a cheap ocean cable service, extending to every possession of Her Majesty.

The carriage of letters at any known speed consumes time, and the length of time consumed depends on the distance traversed. The telegraph, on the other hand, practically annihilates space, and in this one respect has immeasurably the advantage over the ordinary postal service, especially in the case of correspondents who are separated by the greatest distances.

We can as yet but faintly appreciate the extent to which the telegraph may be employed, because its use heretofore has been restricted on long-distance messages by almost prohibitory charges. If messages can be exchanged between places not far apart, let us say between London and Edinburgh, or Toronto and Montreal, the gain in time by the use of the telegraph is inconsiderable. But if the points of connection be far separated, such as London and Melbourne, or Ottawa and Cape Town, the comparison between a postal and telegraph service brings out the distinct value of the latter. In the case last mentioned, while it would require the lapse of eight or ten weeks to obtain an answer to a letter by post, if the telegraph be employed a reply may be returned next day or even the same day.

Existing long-distance cables are little used by the general public; it may be said not at all except in emergencies. They are used in connection with commerce, the growing needs of which demand more and more the employment of the telegraph, but owing to the high charges exacted its use is limited to business which would suffer by delay. These cables are in the hands of private companies striving

chiefly to earn large dividends, and who adopt the policy of charging high rates, in consequence of which trade and commerce is unduly taxed and its free development retarded. Were the cables owned by the State, large profits would not be the main object, and precisely as in the case of the landlines of the United Kingdom, it would be possible to reduce charges so as to remove restrictions on trade, and bring the service within reach of many now debarred from using it.

(To be continued.)

POWER CONSUMPTION IN ELECTRIC RAILROADING.

THE Americans have satisfactorily solved the question of power provision for electric cars. We have not done so yet. Therefore no excuse need be offered for calling attention to a paper by Mr. Dodd, read at Cleveland, O. Mr. Dodd recalls his surprise when, 10 years ago, he saw a car fitted with two 20-H.P. motors. The power seemed altogether beyond the size and speed of the car to a man accustomed to 2-horse cars. The difference is due to two or three facts. In the first place a horse can exert great starting effort. Secondly, the extra speed of electrical cars, notably the demand for rapid acceleration, requires a large power; and thirdly, the cars themselves are heavy.

To-day American tramcar practice does not allow a lower limit than two 25-H.P. motors per car, while double and quadruple 25, 50, and even 75-H.P. equipments do not attract much attention. Mr. Dodd proposed to show that the customary car equipment was not after all greater than required by the ordinary laws of mechanics and dynamics.

The one thing to know was the actual train resistance. This is made up of several factors. First, the actual gravity work of a grade, an important factor on the steep grades of tramlines, as compared with the flat grades of an ordinary steam railroad. Next comes curve resistance, important in a sense, but not really of much account in the general power problem. Very important, however, is the acceleration, because of the numerous starts to be made and the loss of time, and because rapid acceleration really proves an economy on fast runs and implies less waste of energy in brakeage. Frictional resistance depends upon two conditions: the state of the track and the quality of the axle bearings. This is the least known and most uncertain and variable. Commenting on several formulæ for train resistance, Mr. Dodd has collated a score of instances of trains running at a given velocity for a given expenditure of power. The speeds varied from 25 to nearly 50 miles per hour, the weights from 20 to 95 tons, and the resistances from 16 to 28 lbs. per ton. In all cases Mr. Dodd thinks that the formulæ of Clark, Rankine, Searles, and Wellington allow too great a weight to velocity, admitting it into the equation as the square, Rankine alone not doing this and obtaining better results than the others; indeed, being fairly accurate except for the 95-ton train. Clark is too low all through as compared with the actual resistance, Searles being too high for high speeds and too low for low speeds, as is also Wellington. The author's formula, proposed, is $(18 + 0{\cdot}2\ v)\ E + (7 + 0{\cdot}2\ v)\ T$, where v is the speed in miles per hour, E is the weight of engine or motor car in tons of 2,000 lbs., and T that of trailers. The results give a remarkably close agreement with the cited experiments.

The formula appears rational also in the light of our more modern ideas as to train resistance and the influence of velocity, at one time a terrible bogey when it stalked about on the square. He claims the formula as fairly representing the truth between 25 and 50 miles velocity for ordinary interurban cars on straight and level T rails with modern road bed construction. Turning to the factor of acceleration, this is expressed in terms of the gain in one second of velocity in miles per hour. The force per ton of 2,000 lbs. is equal to the acceleration multiplied by 91·3, or $P = F \times 91{\cdot}3$, F being the acceleration in miles per hour in one second, and P the traction per ton. The limit beyond which acceleration cannot go is the adhesive limit of the wheels, and this may at most be put at one-fourth the weight. Hence the importance at high accelerations of motors on all axles. Mr. Dodd shows a diagram of various accelerations, the maximum limit of 500 lbs. per ton with a deduction of 30 lbs. per ton for frictional resistance being represented at about 26 miles per hour acquired in 5 seconds. The nearest approach to this limit so far, is the starting curve of a General Electric car, made on purpose to experiment with high velocities. The lowest of the six curves given in the diagram is about 15 miles velocity acquired in about 50 seconds, being that of the Chicago, Burlington and Quincy Steam Railway for an 11-car train. Next comes the Manhattan Elevated at 23 miles velocity in 52 seconds, while two electric cars show about 20 miles velocity in 20 seconds.

The highest limit of acceleration ought to be comfortable to passengers if made smoothly, and Mr. Dodd has himself noted stops of a deceleration of 475 lbs. per ton without discomfort—a near approach to the maximum limit—but motor men assure him they can stop from 50 miles velocity in 450 feet which implies 365 lbs. per ton. He concludes that adhesion alone limits the rapidity of acceleration if managers are willing to pay for the power.

The vulgar statement that an electric car is a better hill climber than a steam car is traversed by the assertion that when steam engineers put 8,000 H.P. to a train of 800 tons the difference will be less apparent. Steam locomotives carry their own boilers and are limited by this, and so it happens that grades must be kept flat and conditions assimilated to what is really a very small motive power. The conditions are so very opposite. A steam locomotive is a very proper machine for high speeds and long journeys with few stops, for it is merely necessary to overcome running resistance. Electricity is suited to frequent stoppages, and must be fitted to apply acceleration, the train running by momentum almost as soon as all the acceleration has been put into it. Also grades are necessarily steeper, and that power which furnishes acceleration can also do heavy haulage on grades.

Grades of 11 and 13 per cent. occur in electrical practice, and these are comparable with acceleration. Thus a 9 per cent. grade implies 180 lbs per ton; 11 per cent. = 220 lbs.; 13½ per cent. = 270 lbs. Observations of 12-ton cars, after the acceleration is over, show 20 miles per hour. By the author's formula this gives a horizontal effort of 264 lbs. or 22 lbs. per ton, which represents 14 H.P. At 75 per cent. efficiency the trolley input is 18·8 H.P., or 14 kw. = 500 volts × 28 amperes.

An ordinary double truck interurban car weighs 15 tons without motors; these weigh 3,000 lbs. With passengers the total weight is, say, 20 tons. They run at 28 miles on a level; this works out at 23·4 lbs. per ton, or 472 lbs. total, = 35 H.P. With 82 per cent. efficiency for their large motors, this is 43 H.P. or 32 kw. trolley input = 500 volts × 63 amperes, or 32 amperes per motor. The maximum acceleration on the Akron, Bedford, and Cleveland line was 1·25 miles per hour every second = 114·5 lbs. per ton, or a traction of 2,300 lbs. for the 20-ton car. The speed at this pull was 18 miles per hour on the curve diagram. The motors were thus giving 110 H.P. At 80 per cent. efficiency this gives 138 H.P. = 103 kw., which at 500 volts represents 206 amperes of starting current.

The new Lorain and Cleveland line has cars estimated at 22 tons. They attain speeds of 35 to 45 miles per hour and even 50 miles. Their level resistance is 616 lbs. per formula, w being 22 and $v = 50$. This is 82 H.P. or 100 H.P. at the input. The voltage is high, about 600. The feeders are heavy, and 550 volts may be assumed at the motor terminals, representing 135 amperes of current. Judging by the running an acceleration of 150 lbs. per ton is maintained up to a speed of 25 miles. Then as the controller is cut out, the speed increases and current falls off with the acceleration decrease. The effort is 254 H.P. or 317 H.P. of input at the motor. This represents a current of 430 amperes. It is concluded that the apparently heavy equipment is called for to the regular running requirements, and the power is just such as is called for by the mechanical conditions to be filled.

This paper really represents the condition of affairs in America in regard to electric traction, and it is thus deserving of attention. If our electrical trams are to make these speeds they will need to be similarly equipped, and we think that the single line and passing place will need to be relegated to the museum. Anything more time and soul destroying than the interminable waits at these barbarous passing places it is difficult to imagine.

The deterrent efforts of the London County Council prove that body to be possessed of very little appreciation of the necessities of the people. It is simply a crime against the public that horse cars should still be run in suburban London. We do not, of course, advocate the speeds found possible on some of the wide roads of American suburbs, but we do advocate something that will get over the slow starting and poor acceleration of horses, and the waste of time due to the long stoppages at the bye passes. Rapid acceleration to the maximum speed would in itself be an immense gain. It is pitiable to see the industries of the land choked by the ignorance of so many of its municipalities.

The everlasting deputations to see what is done abroad are a crying evil and a shameful waste of money. As well send a deputation abroad to observe if steam locomotion is possible as to send abroad for electrical information, when America alone has as many miles of electrically operated lines as there are miles of steam lines in England.

AUTOMATIC BOILER FEEDING.

WRITING to the *Scientific American*, Mr. E. G. Watson discusses the automatic feeding of water-tube boilers. In a certain water-tube boiler having 500 square feet of heating surface, the water contents are about 600 lbs. At only 5 lbs. of evaporation per square foot, this would be wholly dissipated in 15 minutes, while a very short time would suffice to dangerously lower the water level.

If, therefore, automatic feeding is to become the rule, the feed apparatus must be such as to preserve the water level constant while the boiler is at work, and cease to feed when the boiler ceases to give steam. Yet it is contended automatic feed is essential to this type of boiler. A really reliable automatic feed is by no means simple or easy to devise. Obviously, it should be what its name implies—automatic. Yet we think no automatic boiler feed should be without the strictest attention, and it would appear a reasonable safeguard that there should be a recording instrument on which the pressure of a battery button should record a mark, and the water attendant should be obliged to produce this evidence that he was so many times in the hour actually awake and attending at a point close to the water gauges. The Weir feed pump is said to be wasteful in steam, but very reliable, and it is used for marine purposes, not because it is wasteful, but in spite of that defect. Now all automatic feed devices must be so reliable that this quality will cover every other sin. In the Belleville boiler the feed is regulated by a float device, which opens the feed regulating valve when the water level falls against the resistance of a spring, which closes the valve as the float rises. In this device, if the spring breaks, the boiler is merely overfed. Similarly, if the float were to spring a leak, the feed would be in excess.

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Thus two defects which might occur would not promote danger. The reverse mode of action would introduce two dangers. The Thornycroft regulator is a float inside the boiler. In Normand's two boiler torpedo boats the boilers are connected by pipes between their water drums and steam drums below water line, and there is only one feed supply, and all the water is returned from the engines and finds its proper place in the boilers without any supervision except such as is necessary to supply the regular small deficiency. Yarrow takes steam for his feed pump from near the water line, and the feed pump works at the usual rate so long as this pipe is above water, but if there is too high a water level the pump is fed with water, and works slowly, so that though some loss is made the feed pump acts to reduce water level if too high.

Surface condensation and the return of all water to the boilers reduce the risks and troubles with feed apparatus very considerably. None of these appliances are referred to by Mr. Watson, yet we believe all are reasonably satisfactory, especially on the above closed system possible with surface condensation.

THE END OF THE HORSE.

L'Energie Electrique quotes one Pierre Giffard: "This is indeed the end of the horse." In a certain dialect story, in which a donkey was wound up a mill hoist, the man who tried to land the animal endeavoured to do so by pulling him by the tail. The result seemed to justify his expression, that there were two ends to a jackass, and one of them was the wrong one, for it kicked. Whether the right end of Pierre Giffard's horse has come the near future should prove.

The statement was made on the strength of the results of the recent automobile trials in France. Our contemporary states that of 19 vehicles three were electrical. The electrical vehicles ran 66 kilometres without recharge, whereas the steam and petroleum vehicles took on fresh supplies, and all along the route were visible vehicles filling up supplies. The tests in question were made on October 6th and 12th. There were three routes of about 40, 45 and 67 kilometres repectively; the first was the most easy, the second was the hardest with heavy gradients. The third route was long and difficult. The route seems to have been chosen to the advantage of steam vehicles, the gradients coming in at the end of the journey. Our contemporary devotes several columns to these trials which were made upon vehicles of commercial type, such as are employed by Parisian houses of business, and resemble somewhat a windowless omnibus. They have evidently obtained a good foothold in Paris, and it can hardly be doubted that they have arrived at such a pitch of perfection that a steady improvement and development may now be expected.

The Jenatzy van had a battery of 1,360 k. in 44 elements. The front wheels carried 1,610 k., the back wheels 2,540 k., in working order. The empty vehicle weighed, with the driver, 3,090, and the load was 1,060, giving a total of 4,150 k. as above divided.

Last year, *L'Energie Electrique* estimated that 120 watt-hours of energy were necessary per ton kilometre. This figure had come down to 100 watt-hours in June last, and it was now estimated as only about 85 on the route Versailles and St. Germain at a speed of 12½ kilometres. In the long descents, as to the bridge of Suresnes, over 50 per cent. of the energy spent on this section was recuperated, so that the actual expenditure was as low as 30 watt-hours per ton kilometre.

The conclusions of our contemporary are all in favour of the electric vehicle for large towns or for such work as that of a country doctor where there is a convenient charging station, which, as a rule, will be available at no great distance. Electrical works will find in these vehicles a new source of income.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE meeting of the Institution of Electrical Engineers on Thursday, the 22nd inst., was devoted to what is popularly known as "wireless telegraphy." Mr. Evershed's paper on "Telegraphy by Magnetic Induction" was down for reading, but the author followed Dr. Lodge's example, and gave a summary of his paper without attempting to read it in detail. He stated that the principal question was that of cost, and this resolved itself into a consideration of the power taken to work the receiving devices; only a limited amount of power was obtainable, and the indicator must respond to minute power magnitudes. He referred to the calculations he had made with regard to communication with the lightships round the coast of Kent, and to the experiments which followed; afterwards proceeding to discuss absorption by earth and sea water, and the apparatus, circuit, transmitters, and receivers which had been suggested or employed.

Mr. Preece resumed the discussion; but in addition to his verbal communication, had put on record a condensed account of his experimental work in the form of another paper, with the title of "Ætheric Telegraphy." He thought many would be astonished to find that so much work had been voluntarily and cheerfully done. The earlier apparatus of 1892 was cumbrous, but this objection had been overcome, and the battery now used consisted of 15 dry cells. The apparatus had been evolved by simple plodding experiment. The system was made practical by the calling apparatus of Mr. Evershed. The system was now as simple, practical, and cheap, and also as effective, as any form of telegraphic apparatus that exists. It has only been used between Lavernock and Flatholm, because nobody has asked for it anywhere else.

He corrected the impression that Mr. Stevenson had done experimental work in the North of Scotland, and stated that no attempts were actually made to communicate with Muckle Flugga, the most northernly of the Shetland Isles, but he had arranged for a demonstration near Edinburgh to prove to Mr. Stevenson that the ideas suggested by the latter gentleman were erroneous. He thought that a good many of the "facts" now brought forward would require a good deal of modification.

Prof. Fleming stated that the communications opered up many points for discussion of an interesting character. Omitting such systems as were only suggestions, and those which did not really fall within space telegraphy at all, he gave two divisions into which practical methods fall, (*a*) the closed coil system, *e.g.*, Preece and Lodge, which might be regarded as embodying an air core alternating current transformer; and (*b*) the Marconi and others using a detector of the Branly type, *i.e.*, a discontinuous conductor. The view he took of the long wires employed with coherer systems was that they integrated the electric force into E.M.F., which breaks down the non-conductivity of the coherer. He then showed by experiment that it is not necessary to "tune the wings," and that resonance did not come in, but that the relative position of sender and receiver is important.

Prof. Fleming then proceeded to describe some experiments at University College and in Regent's Park on the absorption of water and function of the earth as a conductor in such systems. The waves were produced at comparatively long intervals, like "twanging a fiddle-string once a week." The open coil system wants a new transmitter to do to the ether what a steam whistle does to the air. No doubt then we shall see Board of Trade regulations for the use of the ether. He tersely described so-called wireless telegraphy as not wireless, but only telegraphy with less wire than we are generally accustomed to.

General Webber reminded the Institution that in 1882 Mr. Willoughby Smith forecasted what might be done, in directions since rendered prolific, when describing Dolbear's new telephone, and it seemed to the speaker that what was then said formed the starting point of modern work.

Mr. Whitehead dealt with the criticism his equations had undergone, and argued that everything depended upon the question, Do Maxwell's equations apply? He cited works of Prof. J. J. Thomson, Hertz, and Oliver Heaviside, and concluded an elaborate defence by stating that if his equations had to go, Maxwell's equations have to go also; if these are not true, where are the equations to be substituted for them?

Sir Henry Mance suggested that instead of making and breaking the tone of the signal might be altered, and from the alteration in note the message might be transmitted letter by letter.

Another speaker considered that sound might be transmitted through the sea, and electrical means employed to pick up the sound waves at the receiving stations. He went into the means of doing this in some detail, and referred to experiments made last century in the Lake of Geneva to prove the feasibility of the proposal.

Prof. Ayrton added to Mr. Whitehead's defence, discussed absorption, and pointed out that while a lightship might be made of wood, one cannot imagine a lightship floating without any sea. He asked Dr. Lodge to state the actual amount of energy required in order to make the magnifying telephones sing out.

Here the discussion proper gave way to a discussion on the discussion. Mr. W. P. Granville considered that the evening had been spent on a number of subsidiary papers, but that

there had been no real discussion. The President had no wish to curtail the discussion, and after some further remarks, it was decided to spend another evening on the subject.

Dr. Lodge then spoke on the discussion as reached. He was glad that Mr. Evershed had shown what he had done. Much that he might say would be reserved for his final reply, when he would give particulars of the power required by his magnifying telephones. As regarded Mr. Whitehead's work, he thought one had better take his equations as correct until somebody else substituted something else for them. A delicious little bit of mathematical demonstration followed, which might have been more exhaustive had not, as Dr. Lodge remarked, the blackboard been so extremely small. After a reference to some work now in hand by Prof. J. J. Thomson, the discussion was again adjourned until the first meeting in the New Year.

CORRESPONDENCE.

Cowper-Coles Electrolytic Cyclic Process.

I have just read in the number dated November 25th the article published by you relating to Mr. Cowper-Coles's electrolytic processes. Allow me to inform you that the so-called invention of Mr. Cowper-Coles is nothing but an infringement of my own electrolytic processes, patented both in France and abroad in 1892 for the extraction, separation, and refining of metals. Moreover, you can convince yourself of the truth of this by reading the enclosed article.

I shall be greatly obliged if you will publish this article in your Review, as this will be the best way for me to establish my rights of priority to the company that have taken up Mr. Cowper-Coles's so-called processes, and who are no doubt ignorant of the fact that Mr. Cowper-Coles's patents are valueless, because they are merely a copy of my patents.

D. Tommasi.

P.S.—Please be kind enough to reproduce the figures contained in my article. I shall also be obliged if you will give me the address of the company working Mr. Cowper-Coles's patents.

[The article to which Dr. Tommasi refers was written by himself and published in the *Electrician* of August 26th last. We regret we cannot accede to his request to republish the same. The address he asks for is the Cowper-Coles Metal Extraction Syndicate, Hayle, Cornwall.—Eds. Elec. Rev.]

I should like to state in reply to Dr. Tommasi's letter which you showed me, that I do not consider that I have, or am, in any way infringing his patents, but if anything, he is infringing my process. There is this great difference between Dr. Tommasi's process and mine. In Dr. Tommasi's process the only features of novelty he appears to claim are a slow revolving cathode (which cannot form subject matter for a patent, as Elmore, Hoepfner and others have used and patented such revolving cathodes), and some secret compound which he adds to the electrolyte. In my process for the treatment of complex sulphide ores the revolving cathode is a matter of detail, and is not even an essential part of the process. Long before Dr. Tommasi published a description of his process in the *Electrician* and other papers, I had used revolving cathodes, and I can produce documentary evidence and witnesses to prove this fact. The only claim for novelty that Dr. Tommasi can possibly claim is in the material he uses for his cathode, or for minor details in the construction of the cell. In the description of Tommasi's process that appeared in the technical journals, he mentions the use of cathodes made out of alloy of aluminium bronze. I have never tried such an alloy myself, as I did not think it would offer any special advantages, in fact, alloying the aluminium does away with the advantages obtained by using pure aluminium, which I have used with great success, having discovered that aluminium offers special advantages due to the fact that a loose film of oxide forms on the surface, thus ensuring the ready stripping of the metal from the cathode. I shall be pleased to give Dr. Tommasi any further information he may require about my process.

Sherard Cowper-Coles.

The Deposition of Copper.

It seems to me that a better way than the methods now in use for making pipes, &c., of copper by deposition would be to bring the copper sulphate solution to the mandrel in the form of a jet, issuing from a nozzle, at such a high speed that there would be considerable pressure on that part of the mandrel immediately affected; if this worked, it could be applied in many directions, statuary, &c. I would also suggest that other substances, such as pellets of rubber, copper, &c., be incorporated with the swiftly rushing solution; the continual battering of these upon the freshly deposited copper might help to make the "grain" close and even.

Lux.

Johannesburg, *November 20th.*

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Dec. 27th, 1897.	£	s.	Week Ending Dec. 27th, 1898.	£	s.
Antwerp...	410	0	Adelaide	500	0
Brisbane	19	0	Alexandria	30	0
Buenos Ayres. Teleg. cable	990	0	„ Teleph. mat.	56	0
„ „ Teleg. wire	125	0	Algoa Bay	234	0
Calcutta	213	0	Amsterdam	40	0
Cape Town	136	0	Bombay	13	0
Christiana	16	0	Buenos Ayres	2,059	0
Colombo...	25	0	Calcutta	239	0
Genoa	36	0	Colombo	60	0
Melbourne	483	0	Delagoa Bay	44	0
Natal	492	0	Durban	139	0
Port Elizabeth	312	0	Hamburg	110	0
„ Said	50	0	Las Palmas	31	0
Reval	90	0	Marseilles	18	0
„ Teleg. mat. ...	300	0	Melbourne	2,246	0
Rotterdam. Teleg. mat.	30	0	Penang	107	0
Santos	52	0	Singapore	61	0
Stockholm. Teleg. mat.	24	0	St. Petersburg	30	0
Sydney	395	0	Sydney	689	0
Total	£4,198	0	Total	£6,706	0

Application for Discharge.—On January 16th, at 2 p.m., at the Court House, Wandsworth, an application for discharge by W. R. Smith, electrical engineer, of Hitherfield Road, Streatham, will be heard.

Bankruptcy Proceedings.—The creditors of Thomas King, electrical engineer, Maidstone, and also late of Brighton, met on the 22nd inst. at the London Bankruptcy Court, and appointed Mr. F. W. Davis, C.A., Finsbury Pavement, E.C., as trustee, to wind up the estate in bankruptcy, with the assistance of a committee of inspection. The debtor, who started in 1893 with £500 capital, attributes his position to loss on the Brighton business, and to insufficiency of capital. He returns his liabilities at £2,497 19s. 6d. (unsecured £2,103 13s. 5d.), and his assets at £1,109 11s. 11d.

Liquidation Notices.—At meetings of the B. C. Electric Syndicate on November 30th and December 16th it was resolved to wind up voluntarily, and Mr. A. E. M. Davis (McAuliffe and Davis) was appointed liquidator. Creditors of the company should send particulars of their debts and the usual information to Mr. Davis, at 1 and 2, Great Winchester Street, by January 23rd, 1899.

Creditors of the United Ordnance and Engineering Company are to send their names and the usual particulars to Mr. W. E. Davies, liquidator, by February 3rd.

Books Received.—"Kalkulos sobre las Kanerías de Agua," by A. E. Salazar, Professor de Fisika, Industrial de la Unibersidad de Chile. Santiago de Chile: Hume I Ka, Aumada, 357.

"Advanced Inorganic Chemistry," by G. H. Bailey. London: W. B. Clive. 3s. 6d.

Calendars, Lists, &c.—Messrs. E. F. Moy, Limited, electrical engineers, of Camden Town, have brought out an 1899 wall calendar, the general arrangement of which is very artistic.

We have received from Messrs. Marshall & Co., electrical and mechanical engineers, of Belsize Works, Clayton, Manchester, a price list and small sample card of lead seals.

Messrs. D. Bruce, Peebles & Co., of Edinburgh, are wishing their friends the compliments of the season in a very neat card which gives a view of their works and of one of their enclosed motors.

The British Boiler Fluid and Engineers' Stores Company, of Limehouse, send us lists of their "Dejecoline" boiler scale removing fluid.

We beg to acknowledge with thanks the receipt of the usual charming and useful pocket-books from the Brush Electrical Engineering Company, Limited.

In accordance with what has been its very good custom for some years past, the Electrical Power Storage Company again sends out to its customers and friends an extremely useful blotting pad, with monthly calendar for 1899 at the top and memoranda book, interleaved with blotting, fixed conveniently on the left. We have no doubt that these pads prove of great service in many electrical offices, as does also the information of a general character which is given in the memo. book before mentioned.

Change of Address.—Messrs. Salviatia, Jesurum and Co., importers of Venetian glass, electroliers, &c., have just removed from 213, Regent Street, W., to Regent House, Regent Street, W.

Dissolution of Partnership.—Messrs. Nastorg, Burt and Co., bronzists and electric light fittings makers, whom we recently announced had taken new premises at 123 and 125, Oxford Street, W., have dissolved partnership. Debts by Mr. Charles Harley Burt, who will carry on the business at the new address on his own account.

Electrical Engineering in Italy. — The electrical engineering business carried on in Milan by Messrs. B. Cabella and Co. under the title "Tecnomasio Italiano," has just been converted into a joint stock company with a capital of £80,000.

Extension of Premises.—The Unbreakable Pulley and Mill Gearing Company, Limited, of Manchester, state that plans have been passed and building commenced for the extension of their pulley department, to meet the largely increased demand for the "Wells Unbreakable" pulleys.

German Electrical Enterprise.—The *Financial News* says that when the town of Braila recently invited tenders for electric lighting all the bidders were Germans. A Cologne company named the price at 0·695 franc for 100 watts an hour to private individuals and half-price to the public, with other advantages, if allowed to use for lighting purposes the power house already possessed for the electric road; while a rival company, of Frankfort, offered light at 0·72 franc for public and private use, undertaking to pay into the city treasury one-third of all profits above 7 per cent. on the capital invested and one-half of all above 10 per cent. Here, says our contemporary, is a fair sample of the desperate methods by which Germany seeks to get a footing everywhere. It can hardly be called legitimate enterprise. The Germans appear to be always ready to make the greatest sacrifices—even to the extent of supplying goods at a loss—in order to introduce goods, in the hope that by-and-by they will succeed in elbowing out their English and other rivals. Free indulgence in this desperate policy has already resulted more than once in burnt fingers, and there are signs that they are learning by experience to become more cautious. English traders, who endeavour to supply goods of good quality, do not seem particularly anxious to imitate German methods. They prefer to keep on the safe side, and let their goods, as it were, speak for themselves. This caution is often carried too far; but the trade done is very much safer and often much more satisfactory than that of their German rivals. The quantity or value of exports to any particular country does not always and infallibly indicate the amount of profit derived therefrom.

Hospital Lighting.—Messrs. Wallis-Jones & Dent, of Westminster, have been appointed consulting engineers for the electric lighting and electrical arrangements for the Newport and Monmouthshire County Hospital.

Interesting Action.—The Bromley Bench had an interesting case before it last week. Messrs. Muirhead & Co., electrical engineers, of Elmers End, Beckenham, sued Thomas Mitchell under the Employers' and Workmen's Act of 1875 for breach of contract, claiming the sum of £3 11s. The plaintiffs were compelled to take the proceedings for the sake of discipline at their works. On August 22nd defendant was engaged to make three high resistance boxes, which were necessary for the machinery the firm were constructing to fulfil a contract. The contract had to be completed by the end of October. Defendant worked from August 22nd to September 24th, and he lost a good deal of time by absenting himself, and by unpunctuality. Defendant was to be paid £12 for the whole work. This was based on the amount an average workman would receive if paid 1s. an hour for the job; 9d. an hour was paid whilst defendant was doing the work, and the remaining 3d. per hour was retained by the firm until the contract was completed. Defendant got in arrears with his work, and on September 26th he did not go to work, and sent no excuse. He also absented himself on September 27th, and on September 28th a letter was received from him stating that unforeseen circumstances had compelled him to absent himself from work. On September 29th another man was put on, and he completed the job. As a result of defendant leaving the work the completion of the job brought the total price to £3 11s. above the amount the firm were to pay defendant. After the other man had been put on defendant went to the works, and he was told that he would be held liable for the delay. On October 26th he called again, and was told by the firm that they did not want to press him, and that he might make it up by doing some piecework. Evidence was given by John Parr, the manager of the works, and a workman named Alexander. In defence, defendant said he was detained in London on important business on the days he stayed away from work. He contended that he had been unfairly treated by the firm. Other workmen had absented themselves from work, but the firm chose to make him the sufferer. The Bench made an order against defendant. Defendant disputed the accuracy of the figures which had been quoted. Mr. Snowden said he was willing to take defendant's figures. An order was then made for defendant to pay £3 5s. in a month. Defendant stated that he should like to appeal. The chairman said their were no grounds for an appeal.

Ludwig Loewe & Co.—From January 1st the electrical business of the above company, of Berlin, will be taken over by the Union Elektricitäts-Gesellschaft, and all communications should be addressed to that company at Huttenstrasse, 12-16, Berlin, N.W.

Messrs. Siemens & Halske.—This firm, of Berlin, are declaring a dividend of 10 per cent. for the financial year 1897-98, the net profit for that period amounting to no less than £266,553. In addition to a number of electric tramways the company completed and put in operation 11 different central stations for town electric lighting.

New Company.—A new company has been formed in Aberdeen called the Aberdeen Electrical Engineering Company, Limited, to work the electrical engineering business of Messrs. Botting, Schoolhill. The capital is £10,000, and has been privately subscribed.

New Edition.—Messrs. Whittaker & Co. have just issued a new (4th) edition of "Electric Lighting and Power Distribution," by Mr. W. Perren Maycock, M.I.E.E. They have in the press a new book entitled "Electric Wiring, Fittings, Switches, and Lamps," by the same author, and this will be published in about three months' time.

New Electric Cable Works in France.—New works for the manufacture of electric cables of all kinds are being established at Bohain (Aisne).

1898.—In their usual trade review for the past year, Messrs. Bolling & Lowe say that the commencement of the year "saw the conclusion of the great engineering lock-out, which was shortly followed by the colliers' strike in Wales; this latter took four months to wear itself out without any apparent future benefit to the strikers, whilst it caused great loss both to them and their employers. These two strikes were felt as direct blows to trade generally, but compensation was to some extent found in the activity caused by the Spanish-American conflict, and more recently by the war scare in our own country, occasioned by the Egyptian complications. This gave rise to an immediate distribution of large Government orders for prompt execution. Urgent demand for quick delivery necessitates working overtime, but when reaction sets in, it generally results in lessened occupation for the working man. . . . If we take the contracts now being executed for home purposes, viz, the extension of main line railways, light railways for rural districts, harbour works, local tramways, city subways, water works, and sewage plant, &c., we shall find that they, together with the naval programme, go far to compensate for the diminished quantities and values in our exports of iron and steel. Great development has taken place in all enterprises connected with electricity, both for light and traction, and this power is displacing steam for many purposes. There has undoubtedly been a wave of prosperity over the whole country, and the iron and steel trades have fared well. Prices have for some time been higher than they were last year, both for raw and manufactured materials. . . . . The prospect of a British Pacific cable uniting British Columbia with Australasia is still distant, but an Atlantic cable, 3,165 nautical miles in length, made in France, has been laid thence to the United States. . . . Last year we stated that the question of the metric system was 'under consideration,' but unfortunately no progress can be reported. In conclusion, we may add that it is our impression that there will in the coming year be full employment for the iron, steel, engineering and ship-building trades."

ELECTRIC LIGHTING NOTES.

Aldershot.—The District Council has a report from the Electric Lighting Committee on an electric lighting scheme, recommending that an installation be put down at a cost of £11,000. The report advises that the parish clerk's land be the site of the proposed electric lighting works; responsible firms, if the report is adopted, will be invited to tender for laying down an installation sufficient for wiring 6,000 lamps for business establishments and private houses, and arc lighting for the streets; and strenuous opposition will be offered to the establishment of electricity works within the district as proposed by the promoters of the Aldershot and Farnborough Light Railway Bill.

Alloa.—Messrs. Lowdon Bros., of Dundee, are at present fitting up the large factory of Messrs. John Paton, Son & Co., yarn makers, at Alloa, and already part of the works is lighted by electricity; only one dynamo, which is being worked by the existing boilers at the factory, is in use in the meantime, and it is expected that another five will be put up shortly. The offices, watchhouse, and part of the wareroom are now lighted electrically.

Ayr.—The other day there was an explosion of gas in a street transformer box, the cover being blown off and a flame issuing from the opening.

Barmouth. — Mr. J. Charles Hughes, solicitor, appeared before the Council recently to ask their assent to the application of Mr. David Davies for a provisional order to light the town by electricity. The Council agreed to assent to the application, reserving their right to object to any terms in the order.

Belfast.—The Electric Committee recently authorised the engineer to prepare specification for lighting the new police buildings, and advertise for tenders for the execution of the work. He was also instructed to prepare a scheme for the committee's consideration, of the new mains and extensions of existing mains he would recommend should be laid, and of the plant likely to be required in the near future. The engineer submitted his report on tenders for coal and the results of test of samples from firms who had tendered, and the committee having considered same, accepted that of Mr. J. R. Noble for Welsh coal and Messrs. Macpherson for slack, as being the most advantageous. He further reported that, as showing the growth of the undertaking during the past year, the output had been on December 21st, 1897, 1,963 units, and December 21st, 1898, 3,550 units, showing an increase of about 81 per cent. He submitted a number of applications for supply of current, which were granted. The total number of lamps now connected and applied for is 42,364.

Berwick.—An electric light installation has just been put into the premises of Messrs. Ross Bros., butchers, in Hide Hill, by Messrs. Dalziel & Co., electrical engineers, Newcastle. Several arc lamps of 3,000-C.P. each are supplied from a 3-horse-power dynamo. In the shop there is a small mincing machine driven by a 1-horse motor.

Birmingham.—The City Council have decided to introduce the electric light into the Council House. The entire building will be lighted, the cost of the work being nearly £2,000. So far as possible, the present fittings and pendants, many of which are very handsome and valuable, will be utilised for the new lights.

Bristol.—The Docks Committee has accepted the tender of Messrs. Willway & Sons for an electric light installation at the engineer's office in Underfall Yard.

Chester.—The Council has adopted a recommendation of the Lighting Committee that they be authorised to oppose the proposed application to Parliament by the Lancashire and Cheshire Electricity Company, Limited, and the Lancashire Electric Power Company.

Derby.—The Electric Lighting Committee recently reported that the tenders of Messrs. W. Morley, Thomas Walker, and G. L. White for the supply by each firm of 1,000 tons of coal at 6s. 4d. per ton has been accepted.

Dublin.—The Great Northern Railway Company have resolved to inaugurate a very extensive system of electric lighting in the Dublin station and offices. The contract is said to have been given to Messrs. Coates, of Belfast.

Frockheim.—The electric light has just been put into the bleachfield of Messrs. Douglas Fraser & Sons. The motive power is water, a large turbine wheel having been erected in the bleaching house. Lights have been put into different chambers inside the works, and several are outside in the parks. The hope is expressed that the light may be extended through the village.

Glasgow.—At the Dean of Guild Court in Glasgow on 21st inst. the Corporation applied for permission to erect a generating station in connection with the electric lighting department on ground in Pollokshaws Road. The Caledonian Railway Company appeared as objectors.

It is stated that fresh negotiations have been opened up between the Electricity Committee and the Kelvinside Electricity Company, which will probably lead to a settlement satisfactory to both. A local paper says that the Kelvinside Company have Parliamentary powers to prevent the Corporation from providing electricity for tramway traction within their area. As an electric tramway to Anniesland Toll is well within sight, such a prohibitive power might lead to complications.

Gloucester.—A Local Government Board inquiry was held last week by Mr. H. P. Boulnois, M.I.C.E., upon an application of the City Council to borrow £50,000 for the construction of electric lighting and refuse destructor works for Gloucester. Mr. Robert Hammond, in explaining the details of the scheme, said that the estimate of the capital expenditure was as follows:—Electricity works and mains, £44,000; refuse destructor, £6,000; total, £50,000. The scheme included, besides private lighting, provision for 36 public arc lamps and 266 double 16-C.P. incandescent lamps. The total public lighting units estimated for is 158,950, and private lighting units, 187,500, or a total of 346,000 units. The plant provided for is 600 kilowatts, viz., one 300-kilowatts effective capacity, and one 300-kilowatts set in reserve. The estimated revenue was as follows:—For private lighting (187,500 units), at net price of 5d. per unit, £3,906; public lighting (158,950 units), at net price of 3d. per unit, £1,987; meter rentals, &c., £150; total revenue, £6,043. The total working cost was estimated at 1·85d. per unit—£2,670, or a gross profit on the working of £3,373, which, after deducting charges on loan and sinking fund, £2,426 5s., left a margin of profit of £946 15s., or more than 1d. in the £ on the rateable value. The total cost of dealing with the refuse by cremation was estimated as follows:—Collection, 1s. per ton; burning, 1s. 3d.; interest and sinking fund, 10d.; maintenance, 2d.; total, 3s. 3d., less materials made from clinker and the net value of steam, 10d.—total cost, 2s. 5d. per ton. Mr. Hammond then described the scheme in detail, by which it appeared that the provisional contracts already entered into amount to £25,690.

Greenock.—We briefly mentioned last week the report of Mr. Fedden, borough electrical engineer, to the Police Board. The report contained the following:—Proposed arrangement for private lighting.—Three-wire system: 250-volt lamps. Lighting mains to be laid from James Watt Dock, along one side of Main Street, one side of Rue-end Street, and both sides of Cathcart Street, Hamilton Street, and West Blacknall Street. One side of Jamaica Street, one side of Union Street, and one side of Kelly Street, and short lengths of the side streets, north and south of the main thoroughfare from James Watt Dock to Grey Place, as required. Public lamps.—Public lamps, 44 in number, will be erected on the above-mentioned streets, from the James Watt Dock to Grey Place, taking the place of about 80 gas lamps on the main line and about 40 gas lamps down the side streets. Cost, £20 per lamp per annum, if half the lamps are put out at 11 or 11.30 p.m. If necessary, the police could put on the half-night lamps for an hour or two in the morning during winter months. Plant.—One 150-kw. (steam dynamo) and one 300-kw. (steam dynamo)—15,000 8-C.P. lamps connected, or 10,000 8-C.P. lamps, alight at one time, £10,000; mains, £10,000; buildings, £5,000—£25,000. For electric light spare ways and tramway feeder spare ways a further outlay of £3,700 is proposed, and the total expenditure in connection with the installation is estimated at £30,000. At the last meeting of the Board, Bailie Cameron moved that the Board approve of the report. Dealing with the reason why it was proposed to have no lamps further west than Grey Place, he said that as they were aware the Tramways Company and the Police Board were considering the question of electric traction for the tramways. If the Board or the Tramways Company decided to have electric traction, it would materially affect the nature of the supply of public lighting beyond Grey Place. In regard to the estimate of the plant, he should like to say that the estimate of £10,000 included the cost of boilers. A very important part of the report was what was called electric spare ways. For these a sum of £2,000 had been put down, the object being to have these ways laid down so that, in the event of an immediate demand for electric light from residents in the West End, they would be in a position to give effect to that demand without again going to the trouble of lifting the streets.—Mr. Anderson seconded.—In answer to Mr. Mitchell, Bailie Cameron said that Mr. Fedden had been making inquiries at various establishments in town—engineers and shipbuilders—and he had indications from them that would require very extensive electrical power. Mr. Mitchell proposed as an amendment: "That the report be not approved of, pending the report from the sub-committee, who are considering the question of whether the tramways are to be re-leased to the Port Glasgow Tramways Company, and, if so, whether this board or the company are to provide electric power for driving the cars."—Bailie Watson moved, as a further amendment, "That the portion of the report relating to the public lamps be meantime deferred." A long discussion followed. Ultimately the report as submitted was approved of by a majority.

Hinckley.—The clerk to the District Council has written for full particulars respecting the company which has purchased the Harrow Farm as a site upon which to erect a generating station to supply towns in the Midlands with electricity.

Huddersfield.—With reference to the General Power Distributing Company's Bill, the Council recently appointed a small committee to take such steps and do such things as they may deem advisable for the purpose of affirming the principle that where Town Councils have, with the sanction of Parliament, established undertakings for public benefit, and have not failed in the performance of their duties, it is not right or expedient that powers should be granted to commercial companies to compete with such Town Councils.

Lambeth.—It is stated in the *South London Press* that the Vestry has decided not to inquire officially into the scandal connected with the electric lighting order. All parties have united in letting the affair drop.

Lancaster.—The Corporation have decided to enlarge and extend several mains. The salary of the engineer, Mr. C. M. Johnstone, has been increased from £140 to £160 per annum.

Leigh.—At a joint meeting of the Gas, Water, and Electricity, and the Finance, &c., Committees of the District Council on 19th inst., a letter was considered from Messrs. W. T. Pressland and J. Sturgeon, who wrote on behalf of the promoters of the Lancashire Electric Power Company, stating that the promoters could not see their way to enter into a provisional agreement to bind the company as to the terms in which they would undertake to supply electricity in bulk to the Council. The electrical engineer (Mr. John Foster) presented the following report on the electricity works it is proposed to lay down at the gasworks:—"In purchasing electricity in bulk, your Council will undoubtedly receive it on the high pressure alternating system, this system alone being employed for distributing electricity over large areas. The high pressure alternating current may be supplied in the single-phase or the multiple-phase, and in transforming this high pressure current down to the pressure allowed by the Board of Trade for distributing to consumers, either of the following transformers or converters may be used:—(1) Stationary transformers, having no revolving parts, and giving on the converted or secondary side an alternating current up to 250 volts pressure. (2) Rotatory transformers or motor dynamos, giving on the secondary side a continuous current up to 500 volts pressure. In transforming alternating currents from high to low pressure, the following losses

are incurred:—(1) By stationary transformers, from 20 to 30 per cent., according to the hours of no load. (2) By rotatory transformers, up to 25 per cent. It will be seen that in purchasing electricity in bulk you would be able to give to your consumers a supply either on the alternating current system, or on the continuous current system; and, in considering which is the best system to adopt, the following particulars must be taken note of. In the first place, the highest pressure the Board of Trade will allow an alternating current to be taken on the consumers' premises is 250 volts, whereas the pressure allowed on the continuous current system is 500 volts on three wires. This difference in pressure would mean an extra £1,000 on the tenders received for mains, and, further, the alternating current is unsuitable for traction and power work, and not nearly so efficient for arc lighting purposes as the continuous current. It will be seen from the figures following, which give capital and working costs of the above systems, that there is a slight saving of ·08d. per unit sold in the working costs on estimate No. 1 (on the alternating current supply) over those of estimate No. 2 (on the continuous current supply). From a consumer's point of view, this saving is more than counterbalanced by the advantages he would obtain in receiving a supply on the continuous instead of the alternating current system. Taking this into consideration, and keeping in view the possibility of your Council requiring in the near future a supply of electricity for the propulsion of trams, I think you will agree (whether the Council purchase electricity or generate it themselves) that the best system of distribution to adopt is the continuous current, which system you have previously adopted, and which has been approved by the Board of Trade. The first estimate of the engineer amounted to £6,332 and the second to £6,382. The cost of working, as per estimate No. 1, which is the approximate cost of station and mains required if electricity is purchased in bulk and distributed on the alternating current system at 250 volts, on an annual sale of 150,000 units, electricity purchased at 1¼d. per unit, would be 2·74d. per unit, and as per estimate No. 2, with the electricity purchased in bulk and distributed on the direct or continuous current system at 440 volts, 2·82d. per unit, or a saving of ·08d. per unit by adopting No. 1 scheme over No. 2; the latter, however, having the advantages of a continuous current supply. With electricity purchased at 1d. per unit, the cost of working would be: No. 1, 2·44d. per unit; No. 2, 2·52d. By erecting the proposed station at the gasworks several distinct advantages are gained which materially aid in reducing the cost of production from that of an isolated station, namely:—The same staff at present employed by the gas department will be able to carry on the work of the electrical department, with the exception of the dynamo attendants. The same boilers will be utilised by both departments. Fuel will also be obtained at an exceedingly cheap rate in consequence of the above boilers being able to utilise the waste heat given off the gas retort furnaces in the generation of steam. These advantages alone would enable you to produce and distribute electricity at as cheap a rate as by buying it in bulk and then distributing it. In comparing the working costs it must be borne in mind that the generating station intended to be erected will be capable of holding plant to the extent of 600 kilowatts, the plant for which you have received tenders has a capacity of 200 kilowatts, capable of supplying 150,000 units per annum, and it is on this quantity that I have based the whole of the working costs given in this report. It is not to be assumed that these working costs will be reached the first or second year, but only on the output reaching over 150,000 units per annum. In the tables are computed the capital and working costs, and from these figures it will be seen that on reaching the annual consumption of 150,000 units your Council will be able to generate and supply electricity at a price as low as purchasing it in bulk at 1¼d. per unit. Should your Council be able to purchase the 150,000 units at 1d. per unit (which is rather doubtful for the quantity) you then would only be able to save about ·17d. per unit on estimate No. 1, or ·09d. per unit on estimate No. 2:—Cost of station and plant, as per tenders and estimate, capacity, 150,000 units per annum; electricity station (approx.), £1,855 9s.; engines and dynamos, £2,784; switchboard, £715; accumulators, £1,500; crane, £196; water softener, £150; mains, meters, &c., £3,036; total, £10,236, interest and sinking fund borrowed for 25 years at 2¾ per cent. per annum, £690 18s. 6d.; working costs on 150,000 units sold at 2·61d. The above working costs have been taken from the working costs at Nelson with a consumption of 71,000 units per annum, and Lancaster with 147,000 units. Should your Council put down a generating station and afterwards decide to purchase electricity in bulk, the following plant would most probably be thrown out of use: Two engines and dynamos, £2,784; portion of switchboard, £315; accumulators, £1,500; total of first cost, £4,599. According to the demand and the prices obtained at the present time for good second-hand direct-coupled engines and dynamos, there should be no difficulty in selling the above plant and obtaining as high a price as 70 to 75 per cent. of its first cost—say, £2,200 for the engines, dynamos, and switchboard, and £300 for the battery, which would bring the loss down to £2,099. It might be possible to dispose of the battery at a much higher price than that quoted above." It was resolved, says a local journal, that tenders in connection with the erection of electricity works be accepted, viz.:—Mather & Platt, Limited, for steam dynamos and steam and exhaust pipes, £2,784; Chloride Electrical Storage Syndicate, Limited, for the supply and fixing of accumulators, £1,500, and £85 per annum for maintenance (if required); British Insulated Wire Company, Limited, for the supply and laying down of mains and underground work, £1,537 19s. 3d.; Chamberlain and Hookham, for the supply of 60 meters, £304 10s.; James Carrick and Sons, Limited, for the supply and fixing of an overhead travelling crane, £196; Mather & Platt, Limited, for the supply and fixing of a water softener, £150; and Dorman & Smith, for the supply and fixing of a switchboard, £715.

Liverpool.—The monthly official report, which was presented to the Electric Power and Lighting Committee last week, showed that there had been a satisfactory increase in the supply of the electric light for private and Corporation purposes. It was resolved to extend the electric mains in Pembroke Place, Duke Street, Leece Street, Manchester Street, and the Old Haymarket, and to lay mains for tramway traction in Aigburth Road, Paradise Street, and Lord Street.

London.—Last week the St. Luke's Vestry consented to the application of the Smithfield Markets Electric Supply Company, Limited, to lay their mains in the parish. The Metropolitan Electric Supply Company, Limited, wrote stating that it was not their intention to proceed this year with the proposed application to the Board of Trade for a provisional order to supply electricity in the parish.

Lynn.—The Council has referred it to two sub-committees to report as to the streets necessary to be lighted by electricity, and to recommend the positions of the lamps in their respective districts. Prof. Robinson has been asked to advise as to the staff required for the new works, the salaries recommended to be paid, and the time at which the staff should be engaged. The resident engineer, Mr. Leigh Robinson, reported to the committee as to the progress of the works, and was asked to attend the monthly meetings of the committee.

Merthyr.—The Merthyr Chamber of Trade last week decided to give their support to the scheme which is being promoted by the British Electric Traction Company for lighting the town with electric light.

At a meeting of the Urban District Council the Electric Lighting Committee reported that they had fully considered the proposed scheme for the electric lighting of the town, and had interviewed two officials representing the British Electric Traction Company, who were the promoters. These officials had stated that the company were unable to agree to the conditions laid down by the Council, but were prepared to offer the following terms:—For public lighting, 4d. per Board of Trade unit, and for general consumers an average charge of 6d. per unit. The matter was eventually deferred to a special meeting of the Council sitting in committee, and it was agreed to engage an electrical engineer to advise the Council.

Middleton.—The town clerk last week reported to the Electric Lighting Committee that he had received a communication from the Lancashire Electric Power Company informing him of their intention to apply to Parliament for power to supply electric current in South Lancashire and North Cheshire over an area of 1,600 square miles, and to compete with the local authorities in such area. The committee resolved to recommend the Council to oppose the scheme.

Newington.—The Vestry recently invited applications for the appointment of resident engineer for the electricity works now building. There were 77 applicants, and according to an exchange, Mr. J. R. Blackie has been appointed.

Oldham.—The Electric Light Committee has decided that an assistant engineer be appointed for the electricity works at a salary of £100 a year, in order to allow Mr. Newington to look after outside work.—The town clerk stated that the Lancashire Electric Power Association intended introducing a Bill in the next session of Parliament to enable them to supply electric energy throughout Lancashire and the principal towns in Cheshire. If they got the powers it would be a serious matter to the public authorities who supplied electric power. The Bill would require to be watched, and he thought every town in Lancashire and the main towns in Cheshire would oppose it. He had received from the Lord Mayor of Manchester a circular, which had been issued to municipal authorities, calling attention to the Bill and the serious nature of its proposals. The Lord Mayor called a conference to be held at the Manchester Town Hall on January 10th, with the view of organising opposition to the Bill. The Oldham Committee appointed a sub-committee consisting of the chairman (Alderman Harrop), the vice-chairman (Councillor Emmott), the town clerk, and the electrical engineer (Mr. Newington), to form a deputation.

Poplar.—Mr. A. Blackman's report on an electric lighting scheme, which stands deferred to the next meeting of the District Board of Works, makes the following recommendations:—"That the low tension continuous current three-wire system, with a pressure of 460 volts between the outside wires, and supplying energy to consumers at either 460 or 230 volts pressure, be adopted. That the generating plant, to commence with, consist of two 100-kilowatt and two 200-kilowatt generating plants, consisting of four high-speed engines, coupled direct to four shunt-wound dynamos, and four boilers, together with a main switchboard, balancing transformers, storage battery, "booster" dynamos, steam pipes, hot wells, cold water tanks, pumps, economiser, and other necessary adjuncts. That a light iron tramway be constructed from the edge of the Limehouse Cut, across the Board's depot and Yeo Street, to the proposed boiler house. That arrangements be made for taking a supply of cooling water for surface-condensing purposes from the Limehouse Cut. That water-tube boilers be the type of boilers adopted, fitted with mechanical stokers. That a travelling crane, capable of lifting 15 tons, be provided in the engine room. That the mains be laid in stoneware casing, filled in with solid bitumen or similar compound. That the area of supply include the following streets or roads to have mains laid on both sides:—Roman Road, Bow Road, Devon's Road, from High Street, Bow, to Norris Road, Chrisp Street, East India Dock Road, St. Leonard's Road, from East India Dock Road to Dewberry Street, High Street, Poplar; and the following streets or roads to

have mains laid on one side:—Old Ford Road, from corner of Driffield Road to Lefevre Road, Lefevre Road, Tredegar Road, Coborn Road, Fairfield Road, High Street, Bow, from Bow Road to Devon's Road, Devon's Road, from Norris Road to Fern Street, Campbell Road, Violet Road, Morris Road, Woodstock Road, Robin Hood Lane, North Street. That the mains be extended around the Isle of Dogs, to be laid on one side only of the following streets and roads:—King Street, Garford Street, Bridge Road, West Ferry Road, Glengall Road, Manchester Road, New Road, Preston Road. That where gas lamps now exist in the roads and streets not to be lighted by arc lamps and through which mains are to be laid, such lamps be utilised for incandescent electric lights. That 54 10-ampere arc lamps and 71 7½-ampere arc lamps be provided in the positions shown on plan, to be replaced at midnight by incandescent electric lamps, and that the existing gas lamp posts in the streets to be lighted by arc lamps be removed. That the charges to consumers be 5d. per unit for the first hour of the maximum demand per day, 4d. per unit for the second hour, and 3d. per unit for all further consumption, for lighting, and 3d. per unit for the first hour of the maximum per day, and 1½d. per unit for all subsequent consumption, for power. That the Board undertake the wiring of private premises where desired by consumers, payment for the same to be made in one sum, or by instalments, at the option of the consumer." The Committee recommends that the engineer be instructed to forthwith prepare the necessary specifications, founded on the foregoing, that tenders for the required plant and machinery be invited, and that the necessary application be made to the L.C.C. for permission to carry out the works to which the consent of that authority is required. Also that it be referred to the Finance Committee to consider the question of applying to the L.C.C., or other authorities, for the necessary loans for the undertaking, including the wiring of consumers' premises, the estimated amount being £79,000. The Committee have also had submitted to them by the surveyor plans for the buildings to be erected, and they recommend that the same be approved, and that specifications and estimates be prepared, quantities taken out, and tenders invited."

River Plate.—The *Review of the River Plate* hears that a change will probably shortly take place in the direction of public lighting for the city of Buenos Ayres, and that a qualified electrical engineer is to be appointed to the post. This will, we are sure, meet with the approval of the electric light and traction companies, who are worried to death in having to deal with a non-technical Municipal Department. The Rosario municipality being of the opinion that the public lighting was not being carried out in accordance with the contract entered into with the River Plate Electric Light and Traction Company, Limited, called in the services of two German engineers, who sent in a most sweeping report condemning everything. The company insisted on the case going to arbitration, as laid down in the contract, and applied to the Courts for same, as the municipality held back. Mr. Ernesto Danvers, M.I.E.E., has been retained by the company, and Mr. Ramon Araya, C.E., by the municipality, but the latter has not yet accepted. There are wheels within wheels in connection with the case, and it would appear that a certain German company is at the bottom of the trouble, as it is desirous of entering Rosario, but without the public lighting contract such a thing would not be feasible, and we know that the company has friends in high places in the city. We shall watch the case with interest.

Rotherhithe.—The Vestry has decided to oppose the granting of a provisional order to the County of London and Brush Company for the supply of electricity in the parish.

St. Pancras.—Last week the Electricity Committee reported having been in communication with the Board of Trade on the subject of supplying consumers whose premises are located on the boundary line of the parishes of St. Pancras and Islington. The question arose as a result of persons living in Brecknock and York Roads desiring to be connected with the St. Pancras distributing mains. The Board of Trade intimated that it did not appear that they had any power to authorise the erection of overhead wires, and they suggested that the two Vestries should make some arrangement in regard to the matter. The Electricity Committee considered that an understanding for dealing with this and similar cases expected to arise from time to time, should be entered into with the Islington Vestry, and they recommended that the latter should be invited to confer with the committee on the subject. Dr. Walter Smith moved the adoption of the recommendation, and this was agreed to. It was resolved to apply to the London County Council for a loan of £30,000 for extensions at the Regent's Park generating station. On the recommendation of the Electricity Committee, it was decided to inform the Vestry of Hammersmith that the Vestry would, in the event of legislation being initiated, to give effect to the recommendations of the Parliamentary Joint Committee on the supply of electrical energy, support opposition in so far as the recommendations affect the opening of the streets, and the veto of local authorities in regard to provisional orders.

Shoreditch.—Messrs. Waterlow, of Appold Street, have applied to the Lighting Committee for a supply of current for their extensive factories and warehouses. The electrical engineer estimates the consumption at 103,000 units per annum. The engineer is to report on the capacity of the present plant to supply the order. Another order has been promised for a large commercial installation required in 12 months' time. The Lighting Committee's recommendations *re* site for new generating station has been adopted.

Southwold.—The Town Council last week decided to apply for a provisional electric lighting order.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Austria.—The *Chronicle's* Vienna correspondent learns that the Arlberg Railway, which is a State line, is to be worked by electricity. Three electrical firms have jointly undertaken the work and have received a concession from the Government to construct electric works for the whole distance from Innsbruck to the Swiss frontier.

Barry.—Councillor Hamilton Murrell, of Barry, writing from Baltimore with regard to the proposals at Barry to start a tramway service, urges the Council to light the streets with electricity, and allow the same plant to drive the tramway.

Bristol.—The practical settlement of points in dispute between the Bristol Sanitary Committee and the tramway company, to which we referred last week, has been confirmed by the acceptance by the Committee of revised plans submitted by the company and recommended for adoption by the city engineer. The matter in dispute was as to the nature of the support to be given to overhead trolley wires, the contention of the company being that the centre posts required by the Committee to be used in wide streets necessitated deviations of their lines and needless dislocation of traffic which would be avoided by the use of span wires. The matter has been settled by a compromise, and the city engineer informed his committee that he did not think they could do better, for the question resolved itself to a great extent into one of working the lines. One result of the arrangement is that span wires will not be used in the most important thoroughfares around St. Augustine's Bridge and College Green, in other words, in the very centre of the city. The company have now a large staff of men at work laying the new line to Knowle. This is one of the extensions which, humanly speaking, would never have been made had not electric traction been available, the gradient being at parts very steep.

Cardiff.—At a meeting of the Tramways Committee of the Cardiff Corporation, held last week under the presidency of Councillor Andrews, the report of the sub-committee on the electric traction was presented. The report showed that the committee had visited Bristol, Kidderminster, Birmingham, Bradford, Leeds, Sheffield, and other large towns where electric tramways are in use. The sub-committee, after giving details of the system, said that all the more recently constructed tramways inspected were upon the overhead trolley principle, and the sub-committee were therefore unable, except from general knowledge, at the present stage, to make comparisons of this and other systems of recent invention. The only electric conduit system in this country was at Blackpool, where the trolley is being substituted for it, and where there is also a gas motor tramway running to St. Anne's and Lytham. The Blackpool Corporation had refused to permit the extension of the gas traction system further into the borough. At Glasgow, on the other hand, where a section of the tramways had recently been converted into an overhead trolley line, and had been working for some months successfully, the City Council is now contemplating laying down an experimental section of tramway on the electric conduit system. At the present time, in addition to the towns previously mentioned, the trolley system has been adopted in Dublin, Hull, Nottingham, Middlesbrough, Huddersfield, Liverpool, and Halifax. Councillor Tucker moved and Councillor Fox seconded that the report be printed and circulated, and this was resolved upon. Councillor Jenkins thought that by this time the Committee must have sufficient information. He urged that if they delayed, half the allotted time would be gone before they had decided what system to adopt. It was subsequently resolved to obtain copies of the Glasgow report, and have it circulated amongst the members, and the election of another sub-committee was deferred for the next meeting, when the reports will come up for consideration. In the meantime all possible information bearing upon the subject will be obtained.

Coatbridge.—At the Coatbridge Town Council's last monthly meeting it was agreed to support the British Electric Traction's scheme in Parliament. Bailie Reid said he thought they should rather have municipalised the tramway by taking it into their own hands. He thought they had missed an opportunity of working it themselves cheaply and economically. Councillor Bruce said he understood if this Bill was defeated the Council would again have an opportunity of discussing the matter without taking another company in hand, so that Bailie Reid would have a free hand.

Dover.—At a recent special meeting of the Council it was resolved to purchase a motor for watering and cleaning the tramway track at £460, a drilling machine at £28 10s, and a motor for driving it at £57 10s. It was reported that the system used for supporting the motors attached to the electric cars was alleged to be an infringement of patent, but that the Corporation had been protected by contract with Messrs. Dick, Kerr & Co. The town clerk is authorised to act in the matter as circumstances require.

Dudley and Stourbridge.—The relaying of the Dudley section of the Dudley and Stourbridge electric tramway system has now been commenced by the British Electric Traction Company. Already new rails have been laid along a considerable portion of the Birmingham Road, Dudley, and they are placed in granite and not in wooden pavement, as at Brierley Hill. As a matter of fact, the section between the Dudley borough boundary and Stourbridge has been completed; but it is not intended that the electric system will be utilised on that portion until the whole line from Dudley to Stourbridge is finished. It is, however, expected that by the middle of March next the system will be in working order. The

electricity for the line in the Borough of Dudley is to be supplied by the Corporation, who purpose erecting a generating station at Springsmire.

Edinburgh.—Last week the Lord Provost's Committee of the Town Council considered a proposal that the Portobello section of the tramways should be worked by electricity, and it was agreed, after a long discussion, to remit the matter to the Sub-committee on Tramways to fully consider and report.

Electric Locomotives.—It is stated that the General Electric Company, of Schenectady, has received an order for eight electric locomotives for the Paris underground railway.

Glasgow.—The Electric Traction Sub-committee of the Corporation Tramways Department last week discussed the question of the advisability of having a demonstration of the conduit system of supplying the electric energy for the tramways. There was a proposal to make the whole or part of the Govanhill extension underground, but it was decided to continue the trolley, thus having one system of supply from the Springburn power station—to Mitchell Street, Glasgow Cross, and the works at Coplawhill by way of Govanhill. At the same time the possibility of introducing an experiment on the conduit principle was left open. It was considered desirable that a thorough examination of the proposal should be made before committing the city entirely to the overhead system. Last week the local difficulties in the way of the conduit were discussed, and were declared to be insurmountable. Chief among these was the position of the Central Railway in Argyle Street, the roof of the tunnel coming too near to the surface of the street to admit of conduits being formed. It was therefore agreed to recommend to the Tramways Committee that the conversion of the complete horse car undertaking of the city into the trolley system should be proceeded with at once.

Great Orme.—On 21st inst. the Great Orme Tramway Syndicate held a meeting at Llandudno, at which it was decided to accept the offer of Mr. A. H. Preece, electrical engineer, to purchase the undertaking; Mr. Preece has surveyed the system and is quite satisfied with its prospects. The capital of the company is £25,000. The syndicate take shares in the new venture to the extent of their original liabilities.

Grimsby.—Mr. F. J. S. Hopwood, C.B., C.M.G., assistant secretary to the Railway Department, Board of Trade, sat last week for the purpose of hearing objections and amendments to the order applied for by the promoters of the Grimsby and Saltfleetby Light Railway.—Mr. Hopwood announced that almost all objections had been withdrawn. Dealing with clauses Mr. Hopwood, on behalf of the Board of Trade, imposed upon the promoters the obligation of having continuous brakes on the cars, and they required an alteration of a dangerous curve shown on the plans about 12 miles from the commencement of the line.—Mr. E. T. Smith, for the promoters, said that in consequence of the requirements of the Board of Trade and the other amendments of the order on behalf of the Great Northern Railway the promoters would have to increase their capital by £20,000 or £21,000.—Mr. Hopwood said the Board of Trade would be very loth to alter figures which had been very carefully considered by the Light Railway Commissions, but they would be prepared to consider a specific application in writing.

The Jungfrau Railway.—Under the name of the Jungfrau Bahn Gesellschaft, a company has now been promoted at Berne for the construction of the Jungfrau Railway. The Zurich correspondent of the *Financial News* says that the share capital has been fixed at 4,000,000 francs, 2,000,000 francs of which is to be issued at first in fully paid shares. The new concern takes over an electric railway, authorised by a concession on December 21st, 1894, from the Scheidegg, *vid* the Eiger and the Mönch, to the summit of the Jungfrau. The present possessor of the concession, M. Guyer-Zeller, cedes his rights as well as the works at cost price, and, moreover, guarantees the placing of 2,000,000 francs shares and 2,500,000 francs debentures. Up to the present about 2,500,000 francs has been spent on the undertaking. In the early days of the coming year subscriptions will be invited for 1,000,000 francs in shares and 2,000,000 francs in debentures.

Liverpool.—It having been stated that some of the new cars for the Liverpool Corporation would be taken from stock ordered by the Sheffield Corporation, who were unable to make use of them at the moment, the *Liverpool Mercury* learns that the statement is incorrect. The contractors for both the Liverpool and Sheffield cars are the British Thomson-Houston Company, Limited.

The Tramways Committee has directed the electrical engineer, Mr. A. B. Holmes, to bring up plans for the extension of the Paradise Street and Lord Street tramway routes.

Merthyr.—The District Council recently received a letter from the Board of Trade respecting the proposed light electric railway for Merthyr. The Board proposed, subject to the consideration of any represention to be made to them, to make an order on the terms of a draft enclosed; any representations to be made on or before Saturday, January 7th. The matter was referred to the committee of the Council, with authority to communicate their views to the whole Council.

Middleton.—Last week the Town Clerk informed a meeting of the Oldham Surveyor's and Tramways Committee that the British Electric Traction Company had obtained power to make a line from the borough boundary at Chadderton to Featherstall Road, but the authority could not be exercised, without the consent of the Council, for two years after the commencement of the order. If the borough itself made a tram line in the meantime the power of the Traction Company to do it would cease. If the Corporation could get their Bill next August they would still have 15 months in which to lay the rails on that section. They could then run a branch in connection with the Featherstall Road section.

Newcastle.—On 21st inst., in connection with the investigation by the Newcastle Corporation into the respective merits of the electric and cable systems for the new tramways, a journey was made to Middlesbrough by representatives of the various wards of the city, headed by the Mayor (Councillor Harkus). They will visit Leeds in the second or third week of January.

Paisley.—At an extraordinary meeting of the shareholders of the Paisley Tramways Company, Limited, held in the County Hotel on 21st inst., it was agreed to extend the time within which the British Electric Traction Company may exercise their right of purchase, to June 22nd, 1899.

Spen Valley.—The Heckmondwike District Council on 21st inst. heard the report of the clerk on the legal position with regard to the proposal of the British Electric Traction Company to construct a line of tramways through the Council's district, from Dewsbury to Cleckheaton. It was resolved to lodge formal objection to the company's order for the purpose of placing the Council in a position to negotiate terms, and to acquaint the Electric Lighting Committee of the Dewsbury Corporation of the action of the Council with a view to the Corporation expediting their scheme of electric traction as much as possible.

Wrexham.—At a special meeting of the General Purposes Committee, a resolution has been carried by a majority of two recommending the Council to oppose both of the electric light schemes. It was admitted in discussion by Mr. Murless who proposed the motion that the engineer had made the best possible case, but then, it was contended, that Wrexham streets were inadaptable for electric trams, and if the Council did not object the ratepayers would not.

TELEGRAPH AND TELEPHONE NOTES.

Pacific Cable.—Mr. Charles Bright writes to the *Times* with reference to the Pacific cable question as follows:—"What with various conferences, newspaper articles, &c., Pacific cable literature is now becoming somewhat bulky in its dimensions. The subject crops up about once in six months, and has done so for some years past. But we do not get beyond this stage, and it seems as though we never shall do unless the urgency becomes vital—and then it will be too late. Perhaps naturally the Treasury push on one side any expensive scheme which does not appear to be absolutely indispensable at the moment. And thus we shall go on from year to year without getting any further forward, unless the importance of directly linking up the entire British Empire is recognised as the first step to be taken towards a great national and Imperial policy. But words are cheaper than cables, and it would seem that whilst we are contented to go on with our periodic outbursts on the subject of a trans-Pacific telegraph, the Americans will, in the meantime, lay one. Some of us believe in the idea of an Anglo-American understanding, and to these I would—particularly at this moment—commend the notion of combining with American dollars for the purpose of spanning the Pacific Ocean. I will go further and ask, considering the constant strain of European politics, What stronger alliance could we have than an Anglo-American-Japano? A trans-Pacific cable to Japan, with a comparatively short branch to Australasia, would be a necessary accompaniment to the latter. In the course of an article in the September number of the *Fortnightly Review*, and again at the British Association meeting, I ventured to bring the question forward, following on a communication to Mr. Chamberlain, but nothing further has been heard of the matter. It can, at any rate, be said for the periodic expressions in the press concerning the Pacific cable project, that they prevent the public forgetting it entirely; they also prevent any of us imagining it to be *un fait accompli*. By this means, also, we have gradually weeded out some of the objections that used to be brought up—such as the 'enormous and unknown depths,' the 'unfavourable and unknown character of the bottom,' &c.; and soon it will be recognised that the slight extra depth over what has previously been contended with not only introduces no insurmountable difficulties, but is an absolutely favourable feature from a strategic standpoint. Surely we should not wait for another war to work us up to another scare on the subject. If it was a war we ourselves were engaged in, such enthusiasm would come all too late. If Britannia is to continue to rule the waves, she will surely have to keep a sharp look-out in the Pacific as the probable scene of any future naval battle, and it will be conceded, I presume, that naval supremacy must necessarily be accompanied by direct telegraphic communication with the nearest coaling stations, as well as with headquarters. The *Times* has been the means of getting more than one project on right lines, and I trust that your article, together with Sir Sandford Fleming's important suggestions, may be instrumental in bringing about some real action in this matter."

(*Continued on page* 981.)

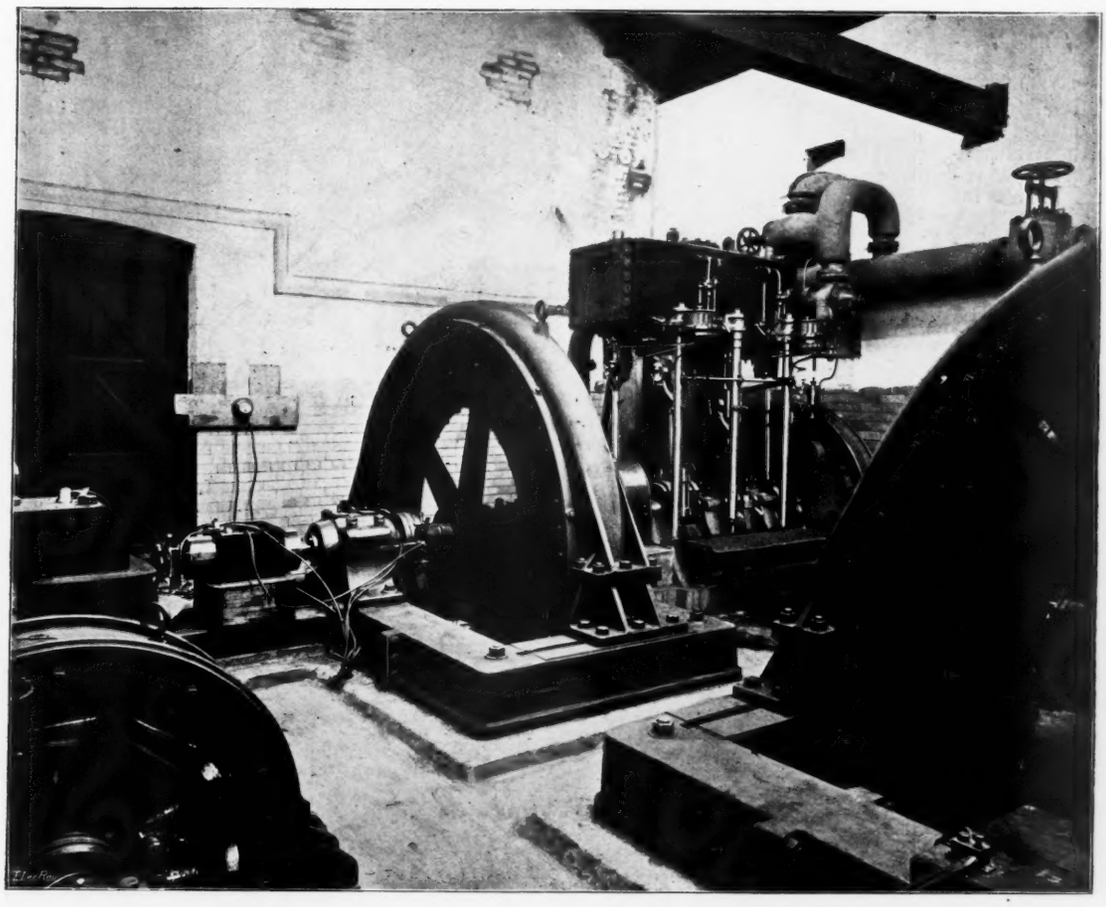
THE LIGHTING OF ECCLES.

The scheme of lighting Eccles was entered upon in January last and is now completed. It consists of plant and mains necessary to supply about 5,000 lamps of 8 C.P. for private lighting in the principal streets, and about 200 street lamps.

The site of the works is conveniently situated for coal and water supply. The Bridgewater Canal is only separated from the generating station by a roadway, and supplies the necessary water for condensing and other purposes, the town supply, however, has been laid on in case of emergency.

The boilers are of the "Lancashire" type 28 feet × 7 feet 6 inches internal diameter, made by Tinkers, Limited, of Hyde. At present only two have been put in, but provisions have been made for extensions in case future demand should necessitate larger power. The working pressure is 125 lbs. to the square inch, and these boilers have been tested up to over 250 lbs. to the square inch both before and since erection. They rest on special seating blocks manufactured by Messrs. Poulton & Co., and these are also placed at all points of contact with the boiler shell. Messrs. Tinkers also supplied the feed and exhaust pipes, pumping and condensing plant.

The water for condensing purposes is pumped from the canal by a centrifugal pump through the condensers, which were made by Messrs. Ledward & Co., and are of the ejector type; the condensed water returns to a tank capable of holding 300 gallons, from which it is taken by means of a duplex feed pump made by Messrs. Mumford, Colchester, capable of delivering 6,000 gallons against a pressure of 125 lbs. to the square inch; this water is pumped through an oil filter to the feed range for the boilers. There is also an injector provided by Messrs. Holden & Brooke, as a standby, which is capable of delivering 1,000 gallons of water per hour, against a pressure of 125 lbs. to the square inch. The oil filter was manufactured by Messrs. W. B. Haigh & Co., of Oldham. The steam engines, two in number, are of the well-known Browett & Lindley compound vertical type, having cylinders,



General View of Interior.

The buildings were erected to plans supplied by Messrs. Woodhouse & Willoughby, of 100, King Street, Manchester, the work being carried out by Messrs. Geo. Macfarlane & Co., Manchester, and operations commenced in January of the present year. The frontage occupies 75 feet, of which 25 feet represents the width of the engine room, the remainder representing the length of the boiler house, and the length of the ground acquired by the Corporation is 198 feet, so that as the present buildings only cover one-quarter of this area ample allowance has been made for future extensions.

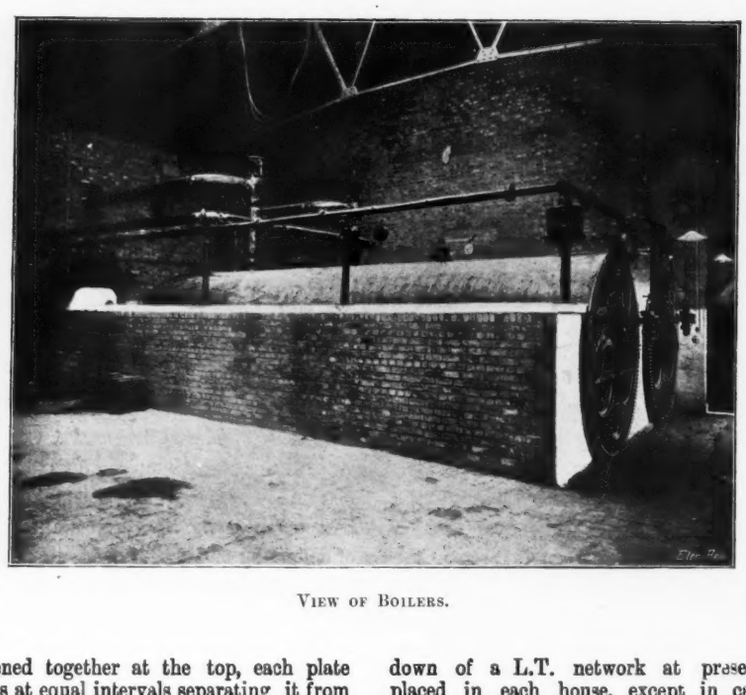
The buildings comprise the engine room 44 feet × 25 feet, the boiler room 42 feet × 45 feet, the accumulator room 10 feet × 20 feet, and the usual offices.

H.P. 13½ inches, L.P. 22½ inches, stroke 16 inches, and run at 203 revolutions per minute. The high pressure cylinders are provided with piston valves, and the low pressure with the ordinary slide valves.

The cranks are set at an angle of 80°, and the governors are of the fly-wheel type, as made by Browett, Lindley & Co., under the Begtrup patents. These are direct coupled to two 120-kw. alternators supplied by Messrs. Johnson & Phillips, each of which has its own exciter coupled direct to the main shaft and capable of giving an output of 3 kw. each. The alternators have 30 armature coils, which are stationary, the field magnets revolving. Messrs. Johnson and Phillips have also supplied a 25-kw. motor alternator, which is expected to take the night load from 12 a.m. till daylight, and also to act as a standby, thus dispensing with the necessity of synchronising the second large plant for any slight demand above the capacity of the machine running. As the load drops, the spare power generated will be utilised in charging the cells, when the alternator will be run as a motor off the mains to drive the direct current machine as a generator for this purpose.

Motor-Alternator and Switchboard.

The accumulators are supplied by Messrs. Pritchetts and Gold, and have a capacity of 1,600 ampere-hours, and consist of 56 cells each containing 63 plates. Each containing box is of lead, standing in a wooden tray on oil insulators, and these are in turn supported on teak rails which are arranged in two tiers, so that there are two rows of cells on each side of the battery room, with a central passage between. The plates are supported by glass bearers, all plates, both positive and negative, being of the Planté type, any one of which can be withdrawn and a new one inserted without its being necessary to stop the working of the cell in any way. The plates are kept apart by glass test tubes which are fastened together at the top, each plate having three test tubes at equal intervals separating it from the adjacent plates.



View of Boilers.

All connections are designed with a view to preventing undue rise in temperature when the batteries are discharging at their maximum.

The switchboard has been manufactured by Messrs. Cowans, Limited, of Salford, and is of novel design, the great aim having been to combine compactness and safety with accessibility, which may be said to have been achieved with signal success.

There are three machine panels, each of which contains a single-pole switch, fuse, ammeter, and voltmeter, the other pole of the alternators being taken direct to another omnibus bar, which can be connected to earth if necessary.

A spare omnibus bar is provided, so that any machine can be run on either bus and the feeders run in parallel or singly as desired.

At present there are two feeder panels, one for the public lighting and one for private consumers; these have also a single-pole fuse, switch ammeter and voltmeter.

All these panels are hinged at the bottom so that they can be swung forward for examining connections; they automatically break contact on leaving the vertical position, so that each panel is "dead," and will remain so until restored to its original position.

The synchronising transformers are situated on the top of the switchboard and make contact with their feet, two of which form the H.T. and two the L.T. terminals—these can be replaced instantly by spare ones, should either or both fail and no danger is incurred in the substitution.

The distribution is on the H.T. system, there being two main feeders—a 19/16 lead covered and a 7/14 lead covered cable laid in wood troughing filled in with pitch, also an earthenware pipe, which runs alongside these two feeders and to the extent of the portion of the area in the original scheme.

The first scheme has been considerably enlarged, and cables have been laid into the residential districts where it is expected electric lighting will be readily adopted. Owing to the fact that the houses are so scattered and the demand not sufficiently centred to allow of the laying down of a L.T. network at present, transformers are placed in each house, except in cases where there are two or three consumers adjacent enough to supply from one house when a cellar on one consumer's premises forms a small sub-station for the supply of the others.

The transformers are by Messrs. Cowans, Limited, Salford,

and have had special side boxes cast on to facilitate the making of the H.T. joints.

The system of charging is similar to that at Brighton, and the Wright maximum demand indicators are installed, the charges being 7d. for the first hour's daily consumption and 2d. for remaining units.

The street gas lamps are being converted in every possible instance, and Messrs. Reason & Co.'s fittings substituted in

The Electric Lighting of a Museum.

the lanterns, there being two 100-volt incandescent lamps connected in series on each pillar. Transformer sub-stations are placed at suitable intervals to transform the current down to 200 volts, which is then conveyed to the lamp pillars, and a concentric main taken up the interior of the post. At present no arc lamps are in position, but it is expected that these will soon be erected in the principal squares and the Market Place.

The whole of the work has been carried out under the direct personal supervision of Mr. Clirehugh, assisted by Mr. F. A. Cortez Leigh, one of the partners in the firm of Lacey, Clirehugh and Sillar, and Mr. Leonard H. Combe, the borough electrical engineer.

THE ELECTRIC LIGHTING OF A MUSEUM

The Manchester Museum, Owens College, has recently been wired and fitted for electric lighting, the supply being taken from the mains of the Manchester Corporation. The building is divided off into bays by means of supporting pillars. Various experiments were made to ascertain the best method of illumination for the several floors, and inverted arc lighting was adopted for the ground floor (the geological and mineralogical section), and the first and second floors, which are devoted to zoology and botany. The third floor, which, like the second floor, consists chiefly of a gallery round a central well overlooking the first floor, is lighted by incandescents on account of the height from floor to ceiling not being sufficient to allow of the use of inverted arcs. On the ground floor there are 16 10-ampere lamps, on the first floor 12 10-ampere lamps, and on the second floor 16 8-ampere lamps. The total number of incandescent lamps on the third floor and in the various offices is about 180.

The photograph of a bay showing the arc lamp in position gives some idea of the method employed and of the result obtained.

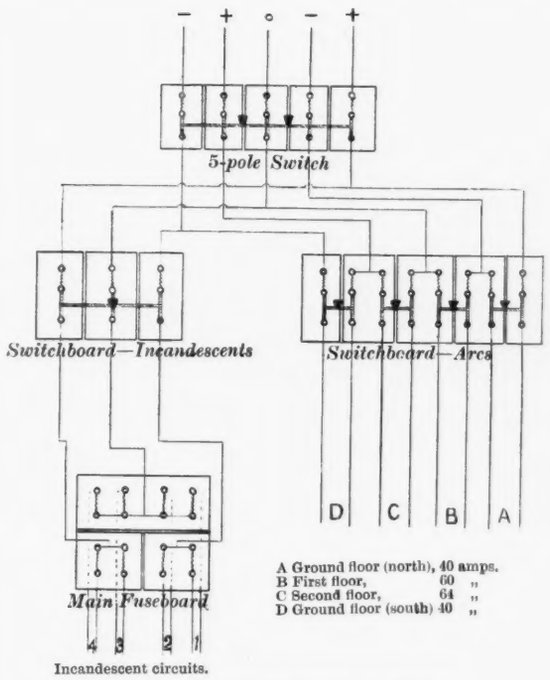
Each bay contains one arc lamp, which in addition to lighting the bay very well, gives the necessary amount of diffused light for the central well of the building. The cases on the third floor are lighted by means of four or six curved brackets, according to the size of the case. The arc lamps are differentially wound and are constructed to burn in pairs in the usual way. On the first and second floors, on account of the ceilings being very low, it was necessary to use lamps with the mechanism above the arc, and in order to avoid having different types of lamps it was decided to adopt this form of lamp throughout. The reflectors are conical in form, and the positive carbon is placed below the negative. It is found that the mechanism, though placed above the arc, casts very little shadow on the ceiling.

The general result of this method of lighting has been found to be very satisfactory. The cases with the specimens are excellently illuminated, and the specimens themselves cast very little shadow. Further, a visitor standing quite close to the case himself casts no shadow, whatever his position with regard to the source of light.

The wiring is carried out on the distribution system throughout; the five mains of the town supply are brought into the building to a five-pole switch. From this switch five cables are run to the porter's lodge to a main switchboard, consisting of a three-pole switch connected to the centre and two outer cables, and four double-pole switches connected to the five cables in the usual way.

The three-pole switch controls the whole of the incandescent system; the four double-pole switches control the four arc circuits. It was decided to wire the incandescent circuits for 200 volts, in order to keep the size of the main cables as small as possible.

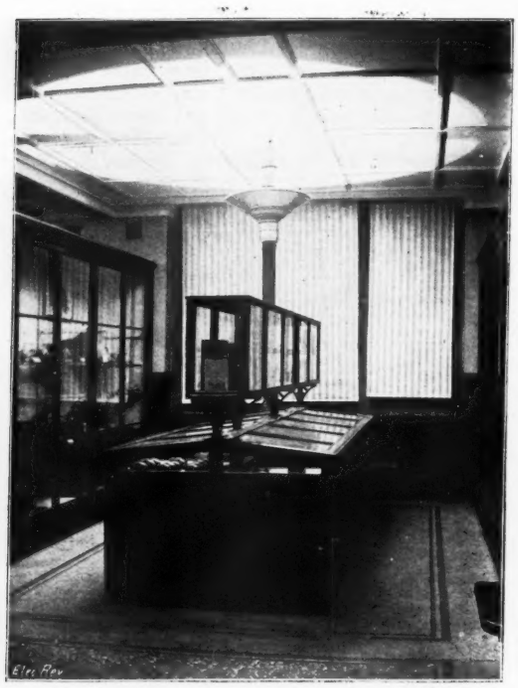
For purposes of balancing, the ground floor is divided into two main circuits of eight arc lamps each. The diagrams show the complete system of wiring.



Museum Lighting.—Diagram of System.

The building is constructed entirely of stone and iron, with concrete floors; the wiring has therefore been erected on the surface in wood casings, specially designed to match the existing plaster mouldings. As far as appearance is concerned, the result is highly satis-

factory, the casings being hardly noticeable. The ground floor being about 22 feet in height, means had to be devised for recarboning and cleaning the lamps. It



Electric Lighting of a Museum.

was necessary to avoid unsightly hoisting gear, and the following method has therefore been adopted:—On the ceiling, just clear of the lamp, two strong hooks are securely bolted through the floor, and a portable ladder has been constructed, which can be hooked on to the supports in the ceiling, the bottom of the ladder resting on the floor. The entire installation was designed and carried out by Mr. G. A. Steinthal, of Manchester.

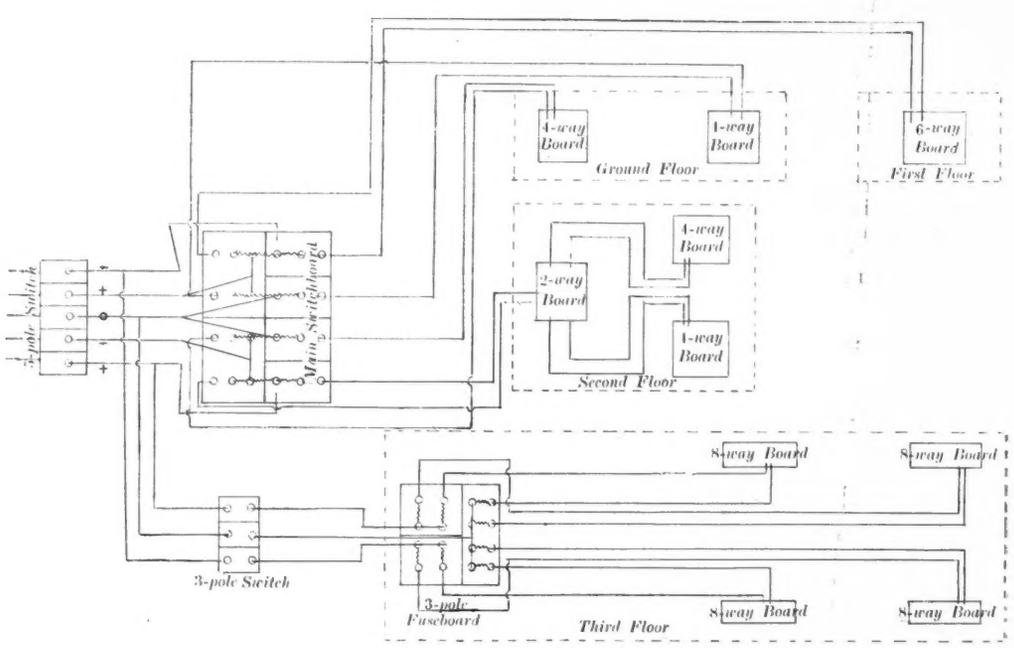
THE THEORY OF THE INDUCTION COIL.

In the Electrical Review, Vol. lxi., pp. 529, 597, we gave an account of a very simple theory of the induction coil which had been worked out by Walter, of Hamburg. The formulæ, giving the theoretical expression for the electrical processes that go on in an induction coil are exceedingly complicated, and Walter succeeded in simplifying these formulæ by neglecting certain factors which experiment with an actual coil showed him to be so small that they were of no importance in the practical calculation.

One of the factors which Walter considered to be so small that it might be safely neglected was the capacity of the secondary coil. Oberbeck* objects to this, and considers that the capacity of the secondary coil in the 30 cm. apparatus used by Walter is too large to be neglected. He estimates that it amounts to 5×10^{-10} farad, *i.e.*, the capacity of a small Leyden jar.

Walter has recently made a second series of experiments† to determine whether there is anything in Oberbeck's objection. He finds that in his 30 cm. coil the capacity of the secondary is only $\frac{1}{4}\frac{1}{5}\frac{1}{0}$ of Oberbeck's estimate, and that the slight oscillations which arise in the secondary are so quickly damped out that they have no influence upon the frequency of the oscillations in the primary. His formulæ he finds are, therefore, quite correct for such coils.

The method by which Walter determined the capacity of his secondary coil was novel and ingenious. He removed the condenser from the primary coil, and also took away the secondary coil. The primary circuit was then broken, and curve showing the time change of the magnetic field was observed by means of a Braun's tube and a rotating mirror. This curve showed a completely damped decrease of the magnetism to zero. When the secondary was placed in position on the primary, the damping was not quite complete, there was a short swing beyond zero and back again, but not more than one oscillation took place. Comparing the duration of this oscillation with that of the primary when the condenser was in circuit, the capacity was calculated by means of the formula $T = 2\pi\sqrt{L\,C}$. The oscillations of the secondary were found to be about twice the frequency of those of the primary, and experiment showed that they had no influence on the frequency of the primary oscillations.



The Electric Lighting of a Museum.—Diagrammatic Sketch of System of Distribution.

* *Wied. Ann.*, 64, p. 193. 1898.
† *Wied. Ann.*, 66, p. 623.

Though Walter succeeded in showing that there was no necessity for taking into consideration the capacity of the secondary in the 30 cm. coil, he found that this was by no means the case when he applied the same tests to a 60 cm. coil (by Kohl, of Chemnitz). When the condenser was removed from the primary, and the circuit broken, well-marked oscillations of the magnetic field were observed, and the duration of these oscillations was found to be equal to that of the oscillations in the primary with its normal condenser in circuit. From these experiments two facts were established, viz.—first, that the capacity of and self-induction of the secondary in large coils is sufficiently great to cause well marked and persistent oscillations; and, second, that to get the best results the primary and secondary circuits must be syntonised. Large induction coils and small induction coils must, therefore, be constructed on quite different principles.

Walter comes to the conclusion that no simple formula can be given for calculating out the dimensions of large coils; but his investigations point out certain directions in which the construction of those instruments might be improved. For instance, it is desirable that the method of winding and the choice of the dielectric should be such as to reduce the capacity of the secondary to a minimum, since the frequency of the oscillations in the primary is thus kept as high as possible. It is upon the steepness of the potential gradients of the primary oscillations that the secondary E.M.F. depends, and the greater the frequency, *ceteris paribus*, the steeper this gradient will be.

It is also of great importance that for all apparatus of this kind a magnetic material should be used having the highest possible susceptibility and the smallest possible hysteresis, in order to get the most rapid oscillations with the least possible loss of energy.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 976.)

American Cables.—The *Times* Philadelphia correspondent says that the secretary of the Navy is sending orders by steamer leaving San Francisco for Honolulu for the gunboat *Bennington* immediately to take possession of Wake Island. The island lies on the route from Hawaii to the Ladrones and is to be used as a cable station. Two corporations have been formed to acquire a Government concession for the projected Pacific cables connecting the United States with Hawaii, the Ladrones, and the Philippines, and, incidentally, with Japan and China. One is the Pacific Cable Company, incorporated in New York with a capital of $5,000,000. This company is promoted by a group of capitalists, headed by Mr. Pierpont Morgan, who now control the Mexican and Central American cables. The other company, incorporated in New Jersey, has Messrs. Abraham Hewitt, Darius Mills, and James J. Hill for its chief supporters.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 4th, 1898 ...	...
New York-Hayti	Nov. 29th, 1898 ...	Dec. 26th, 1898.
Para-Maranham	Nov. 14th, 1898 ...	...
Sitia-Candie	Dec. 15th, 1898 ...	Dec. 22nd, 1898.
Perim-Assab	Dec. 21st, 1898 ...	Dec. 27th, 1898.
Landlines.		
Majunga-Tananarive ...	Dec. 16th, 1898 ...	Dec. 21st, 1898.
" " ...	Dec. 23rd, 1898 ...	Dec. 24th, 1898.
Saigon-Bangkok	Dec. 20th, 1898 ...	Dec. 21st, 1898.
" "	Dec. 24th, 1898 ...	Dec. 26th, 1898.
Communication with Fao (Between Divanich and Semeva)	Dec. 24th, 1898 ...	...

CONTRACTS OPEN AND CLOSED.

OPEN.

Burnley.—January 10th. The Corporation wants tenders for underground electric light cables and switchboard. See our "Official Notices" December 16th.

Christiania.—January 4th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania stating that tenders are invited by the Norwegian State Railways Administration for the delivery of various telegraph and telephone materials. Tenders, in sealed envelopes, marked "Telegrafog Telefonmateriel," must be received at "Styrelsens Expeditionskontor, Statsbanerne, Christiania," by 7 p.m. on January 4th, 1899. A copy of the conditions of contract may be examined on personal application at the Commercial Department of the Foreign Office, S.W., any day between the hours of 11 a.m. and 5 p.m.

Cumberland.—January 2nd. The Visitors' Committee of the Cumberland and Westmorland Asylum invites tenders for the supply and erection of an electric tell-tale clock with 30 stations. See our "Official Notices" December 16th.

Edinburgh.—January 9th. The Council invites tenders for switchboard and boosters for the Macdonald Road lighting station. See our "Official Notices" December 16th.

Glasgow.—January 21st. The Corporation invites tenders for generating plant at one or other of their new electricity works:—Two engines each of 200, and two of 400; three of 1,100, and two of 2,200 indicated horse-power, with dynamos and condensing plant. Specifications, forms of tender, &c., from Mr. Chamen, city electrical engineer. See our "Official Notices" December 16th.

London.—January 31st. The L.C.C. is inviting tenders for four continuous current dynamos, one motor generator, two switchboards and switches, &c., for the proposed Victoria Embankment installation. See "Official Notices" for full particulars.

Norway.—January 4th. The Norwegian State railway authorities in Christiania are inviting tenders until January 4th for the supply of 14 tons of telegraph wire, 3,500 porcelain insulators, 10,000 zinc rods for primary batteries, 1,000 zinc cylinders and 4 kilometres of insulated copper wire. Particulars may be obtained from the Bureau des Telegraphen-Inspectors, Ostbahn Station, in Christiania, and tenders marked "Telegrafog Telefonmateriel," are to be sent to the Expeditionsbureau der Verwaltung der Staatsbahnen, Jernbanetorvet 8/9, Christiania.

Roumania.—January 16th. Tenders are being invited until January 16th by the General Direction of the Roumanian Post and Telegraph authorities in Bucharest for the supply of 2,000 small porcelain insulators, 15,000 medium size ditto, and 10,000 large ditto.

Stirling.—January 2nd. The Burgh Commissioners are inviting tenders for Lancashire boilers, engines, dynamos, pumps, piping, crane, accumulators, switchboard and boosters, arc lamps, and various other apparatus, &c., for the electric lighting of the town. Consulting engineer, Prof. A. B. W. Kennedy. See our "Official Notices" December 9th for particulars.

Tunbridge Wells.—January 11th. The Corporation is inviting tenders for the erection of three telephonic fire alarms within the borough. Tenders to the Town Clerk.

CLOSED.

Barnsley.—The tenders mentioned in our last week's "Electric Lighting Notes" as recommended for acceptance, were last week formally accepted by the Town Council.

Howth.—It is understood that the contract for the equipment of the generating station at Sutton for the Howth electric tramway has been placed in the hands of Messrs. E. Scott & Mountain, Limited.

London.—For supply of battery for electrical installation on the *Shaftesbury* training ship. The following is a list, given by the *Contract Journal*, of the tenders submitted to the London School Board for electrical work:—

		A.
Chloride Electrical Storage Company, Limited	£242 10 0	£20 0 0
Tudor Accumulator Company, Limited ..	215 0 0	18 0 0
D.P. Battery Company, Limited	222 0 0	—
Electrical Power Storage Company, Limited ..	178 19 0	35 7 0
Pritchetts & Gold *	152 2 0	13 0 0

A. Maintenance per annum. * Recommended for acceptance.

For providing electrical installation at the *Shaftesbury* training ship.

Laing, Wharton & Down, Limited	£1,080 0 0
Spagnoletti & Crookes	1,023 15 6
L. G. Tate	990 10 0
Wenham & Waters, Limited	980 10 0
H. F. Joel & Co., and T. Potter & Sons, United, Limited ..	970 0 0
Woods & Co.	959 10 0
Drake & Gorham	938 10 0
Westminster Engineering Company, Limited	880 0 0
Foote & Milne	871 0 0
Electrical & General Engineering Company (recommended for acceptance)	785 0 0

FORTHCOMING EVENTS.

Tuesday, January 10th.—At 8 p.m. The Institution of Civil Engineers. Paper on "High-speed Engines." By John Handsley Dales, A.M.I.C.E.

Friday, January 13th.—At 8 p.m. The Institution of Civil Engineers. Students' Meeting. Dr. Archibald Barr, M.I.C.E. (Professor of Civil Engineering and Mechanics in the University of Glasgow), will deliver an address on "The Application of the Science of Mechanics to Engineering Practice."

NOTES.

Electrical Progress in Prussia.—On account of the official system by which all engines and dynamos are registered in Prussia, it is possible to obtain an accurate idea of the extent to which electricity is being used for lighting and power purposes. The following figures, showing the progress made since 1891, and the chief forms of utilisation at the present date, are taken from a recent issue of the *Elektrotechnische Zeitschrift*:—

Year.	Number of engines.	Aggregate horse-power.
1891	983	49,489
1892	1,260	69,087
1893	1,407	76,045
1894	1,779	101,464
1895	2,458	157,432
1896	2,837	191,935
1897	3,305	258,726

The increase in 1897 was equal to 16·5 per cent. in number of engines and to 34·8 per cent. in H.P. The figures show to what an extent the engine-building industry has profited by the utilisation of electricity for lighting purposes. The tendency is for the size of engines to increase. Berlin Electricity Works has single engines of 1,000 H.P., 1,500 H.P., 1,648 H.P., and 1,900 H.P. Frankfort possesses an engine of 1,500 H.P., and Magdeburg one of 1,000 H.P. The utilisation of the electric energy developed in 1897 was as follows:—Lighting plants, 2,873 engines = 154,772 H.P. Combined lighting and transmission plants, 325 engines = 84,216 H.P. Transmission plants only, 61 engines = 10,785 H.P.

Elevator Accidents.—A serious elevator accident is reported from New York, which appears to be due to a cause hitherto unsuspected. Electrical elevators are variously counterweighted, the counterweights running in guides down the side of the elevator shaft. On the present occasion there was something wrong with the automatic stop catch, and the motor continued to run after the cage had rested at the bottom of the shaft. The result of the overwinding was to crush up the balance weights and bend the bars which held the various weights together. The top weights were pushed out of their framing, and fell the height of the building upon the cage full of passengers. The lesson to be drawn from this is, that the weights ought all to be securely held together, so that the upper ones cannot fall off, nor can the intermediate weights which are held between the upper and lower solid weights be released, as is now possible, when the long connecting bolts are buckled. The immediate cause of the accident was simply the misplaced stop, and it is probable that periodical inspection would have indicated that this stop was, perhaps, becoming loose. We do not know how the automatic stop is fixed and adjusted, but apparently it could not always have been out of place, and must, therefore, have been in some way worked loose.

Personal.—On Saturday evening last Mr. D. P. Regan, engineer and superintendent of the National Conduit and Cable Company, New York and London, was presented with an illuminated address and a case of instruments by the Irish employés of that company. The company are the contractors for the conduit and cable work required by the Dublin United Tramways Company on the conversion of their lines from horse to electric traction.

The Electrical Equipment of the Third Avenue Railroad, New York.—The extent which electric tramway development has attained in America is suggested by the fact that the new departure of the Third Avenue Railroad Company of New York in substituting electric power for cable traction necessitates the construction of a power house in which engines and generators will be placed capable of producing 64,000 H.P. This will be, by all odds, the largest power house—electric or otherwise—in the world, and apart from its construction, and apart from the construction of the conduit system and the line, the cost of the engines, boilers, electric generators, transformers, switchboards, car motors, and other electrical equipments, will, according to official statements, come to something more than one million pounds sterling. The president of the Third Avenue Railroad in speaking of this new undertaking a few days ago, said that the officers and consulting engineers of his company had devoted several months to the investigation of the various systems of current transmission and of electrical apparatus for generating and utilising the power. They had in view the most effective equipment for economising in fuel and labour, coupled with the highest electrical efficiency. He stated also that as this new generating station would be the largest and most complete power plant in existence, his board had decided, in view of the complex features of mechanical and electrical engineering involved, that the work could be best carried out under one responsibility, and for that reason they had awarded the entire undertaking to the Westinghouse Electric Company, the builders of the great electric generators at Niagara Falls. It is interesting to note that the Niagara plant—up to now the most important power plant that has been constructed—develops 40,000 H.P., while the Third Avenue plant will be more than half as large again. The same builders are now constructing an electric plant which will have an ultimate capacity of 75,000 H.P., driven by the waters of the St. Lawrence River. However, neither the Niagara nor the St. Lawrence plant is intended merely for railway, but chiefly for manufacturing and lighting purposes. The former has been for several years successfully conducting electric current over 20 miles to the City of Buffalo, and it is now reaching out to Hamilton, Ontario, and to more distant cities than Buffalo on the American side. The experience which has been gained by these American electricians will enable them to achieve perfectly satisfactory results in the huge installation which is now to be undertaken for the Third Avenue Railroad.

Electrical Resistance of Steels.—H. Le Chatelier has recently determined the influence of carbon, silicon, &c., on the resistance of steel by measurements made on steel bars of known composition, and which had been heated at 600° for several hours. In the case of steels containing carbon, an increase of 1 per cent. of carbon raises the specific resistance—*i.e.*, the resistance in microhms of 1 cm. cube—by 7. The steels are made up of lamellæ of pure iron or ferrite intermingled with the carbide Fe_3C or *cementite*; the specific resistance of these components is calculated to be 9·5 and 45 respectively. An increase of 1 per cent. of silicon increases the specific resistance by 14. According to the author, silicon steels do not contain a definite silicide $Fe\,Si_2$, but are either homogeneous mixtures analogous to the steels containing manganese or nickel, which are isomorphous with iron, or contain the silicon in a dissolved state. Manganese steels can exist in two allotropic forms, which differ in magnetic properties. The specific resistance of the non-magnetic variety increases by 5, and that of the magnetic variety, which is obtained by heating the former at 550° C. for two hours, by 3·5 for each increase of 1 per cent. of manganese. Nickel steels occur in two forms (*Comptes Rendus*, 1889, 110, 283; and 1890, 111, 445), which differ in magnetic properties and also in specific resistance. The latter is greatly affected not only by the content of nickel, but also by the allotropic state of the alloy. In steels which contain less than 5 per cent. of nickel, an increase of 1 per cent. raises the specific resistance by 8—7. Chromium, tungsten, and molybdenum cause only a very slight increase in the resistance of steels, and hence, according to the author, are probably not homogeneously mixed with the metal, but occur isolated as definite compounds.

The City Company and its Consumers.—The majority of the tenants of No. 4, Fenchurch Avenue, E.C., have written to the City of London Electric Lighting Company, Limited, in the following terms:—

4, Fenchurch Avenue, London, E.C.,
December 20th, 1898.

To the City of London Electric Lighting Company, Limited.

Gentlemen,—We are tenants of the premises known as 4, Fenchurch Avenue, in the City of London, to which, by the provisions of the City of London electric lighting orders, a constant supply of energy is to be given at standard pressure. We have been put to very serious inconvenience of late on many occasions by the fact that the pressure has been very considerably below the standard. By the terms of the Electric Lighting Act, and the orders and regulations made under it, we are advised that the company is liable to a severe daily penalty so long as this lasts. We are not, however, anxious unnecessarily to take steps to obtain penalties against the company, but many of us have entirely dispensed with gas, relying upon having a proper continuous supply of electrical energy at standard pressure, and are put to very serious inconvenience, owing to the failure on the company's part to give the proper supply. We desire, therefore, to give you notice that if the supply is not remedied, we shall be compelled to take such steps as may be open to us to compel the company to carry out its obligations. The price charged for electrical energy in the City of London is higher than in any other part of London, and the fact of the energy being delivered below the standard pressure, is to compel consumers to turn on more lamps without much more result than to increase the account payable to the company. If the company does not carry out its obligations, it cannot expect the customers to pay the rates charged.

A communication to the *Times* says that the company has replied thus:—

Gentlemen,—We are in receipt of your joint letter of 20th inst. You are correct in saying that the company is bound to give a constant supply at the standard pressure, but the liability is subject to the company being prevented from giving such a supply by inevitable accident or *force majeure*. We acknowledge that our customers recently have been justified in their complaints, which my board greatly regret. My board can only ask for the kind indulgence of the company's customers in the difficult position in which the company has been placed owing to delay on the part of the manufacturers to complete additional plant by the contract date, and to a series of accidents to machinery which could not be foreseen, and which were partly caused by the great strain put upon the existing plant by the enormous demand which there is at this time of the year between 4.30 p.m. and 6.30 p.m. The board has always adopted the policy of looking well ahead, and ordering additional plant to be erected and ready for use long before it is likely to be required. This was done during the present year, and orders have lately been placed for additional plant for the winter of 1900. All plant is liable to accidents, whether owned by municipalities or companies. The amount of worry and anxiety which the late inevitable accidents have occasioned to the board, and especially to the staff of the company, and for which they receive no sympathy, can only be appreciated by those who have undergone the strain. My board directed that no expense should be spared, and accordingly the company's engineering staff have worked unremittingly both day and night and week-day and Sunday to cope with the difficulties, and we hope with success, as you will have noticed that the pressure during the last day or two has been good. The accidents, &c., have caused great loss to the company, as the meters do not register properly when the pressure is low, and this is apart from the loss of reputation. Therefore, you will see that it is to the direct interest of the company to give a good supply. As regards price, my board have never regarded the question from the point of view of a monopoly, as has lately been alleged *ad nauseam*. The rate of charge in the City is a question of cost of production and of the high capital outlay on all works, due to the conditions obtaining in the City of London. These conditions cannot be dealt with in a letter, but we shall be pleased to go fully into the matter with any consumers. The *maximum* price fixed by the Board of Trade and the Corporation is 8d. per unit, and, under the orders and the contracts the price can be charged until a cumulative dividend for all past years on all the capital employed in the undertaking has been paid. My board, however, have not done this, but have voluntarily reduced the price, and will continue to adopt the same policy as the yearly financial results of the company warrant such a course. The dividends paid on the ordinary shares of the company have been as follows:—1891, *nil;* 1892, *nil;* 1893, *nil;* 1894, 2½ per cent.; 1895, 5 per cent.; 1896, 7 per cent.; 1897, 10 per cent., or an average dividend over the series of years of £3·77 per cent. per annum only.—J. Cecil Bull, Manager and Secretary.

Electro-Chemistry in Switzerland.—A competition has just been opened by the Swiss Society of Chemical Industry for a treatise which shall be of service in aiding the development of the electro-chemical industry in Switzerland. A premium of 2,000 francs (£80) is being offered to the author of the work which shall be adjudged the best of those sent in. All competitors must send in their work by May 1st, 1900, to Herr Dr. Henry Schaeppi, president, Die Schweizerisihe Gesellschaftfür-Chemische Industrie, Mitlödi, Switzerland, from whom full particulars of the competition may be obtained.

"The Greatest Discovery of the Age."

When England set her navy afloat upon the sea,
She had no anticipation of my great discovery,
For 'tis I, the only I, that have made her ships but scrap,
Any nation now may whip her, e'en the smallest on the map,
By "the greatest discovery of the age."

For the blowing up of navies will now be only fun.
An exertion of my will or thought and, lo; the thing is done;
I've combined a wireless telegraph and torpedo dirigible
In so evident a fashion, some say not patentable,
My "greatest discovery of the age."

I care not if the whole shebang was generally known,
I'll be very much *offended* if 'tis not *now* my own.
I'm a Christian and philosopher, as I have truly said;
The laurels of undying fame are resting on my head
For "the greatest discovery of the age."

And when I *am* offended, my forgiveness is complete
When I get a full apology, with humbleness replete.
I've put a stop to wars, but do not rest my claim
On such a simple act as that for everlasting fame.
My super-extra glory rests upon the arts of peace,
I'm in for killing whales and sich and getting at their grease
By my "greatest discovery of the age."

I'm so struck on this my latest that my brain it fairly reels,
And my head it gets to spinning as if 'twere hung on wheels.
I had an oscillator once, a tuneful dynamo,
A revolution 'twas to make, by vibrating to and fro.
'Twas a very great discovery of the age.

But it died ere it was born and resteth as a myth,
And its name now means some coils I experimented with
As another great invention of the age.

To shake the charge of mother earth, another scheme of mine
Beats thunderstorms and earthquakes all along the line.
But wait till 1900. O, won't the people talk,
When I blow up stuff at Paris, when I think so at New York.
By my "greatest discovery of the age."

I've laboured with high frequency to publish and proclaim
That I own some great discoveries, connected with my name;
By high-potential discourse I've tried to bring to light
That there weren't any others who contributed a mite
To such very great discoveries of the age.

But the shade of Cabanellas, and of many others too,
Are upsetting my endeavours and proving my hoodoo.
I content myself in this, that the papers of the day
Will print my schemes sensational and boom me by the way
As "the greatest discovery of the age."

—*Western Electrician.*

Compression in Steam Cylinders.—Following on a previous article, the opinion is arrived at by the *Engineer* that compression is economically neutral in effect in practical steam engines, whatever truth there may be in Rankine or Zeuner, who neither fully realised the actual conditions of the cylinder or the influence of its walls. The full effect of compression can, after all, in our opinion, only be explained, or attempted to be explained, after careful tests with different qualities of steam, wet, dry, and superheated. On this more than anything will depend the result of compression. As a rule, practical men have taken the middle course, and while avoiding the square corner, have also compressed to a degree very much below that of the initial pressure. Compress to the atmospheric line, or a trifle above it, was once the rule for mill engines of large power, and this would generally provide easy and comfortable running, which, after all, is always a *desideratum*. In slow running engines the relation of weight of parts to steam pressure is not considered, and is of small moment, and the shocks of starting and stopping the piston, &c., have been best dealt with by a moderate degree of compression. That, with much water in the cylinder, a higher ratio of compression results only in liquefaction beyond a critical point, is, we take it, proof that the benefit of compression, apart from mechanical effects, must be a function of steam quality. The water in the cylinder cannot be hotter than the cylinder, and will be somewhere between the temperature of the cylinder and of the exhaust pipe, so that a good deal of compression indeed would be necessary to give the heat necessary to vaporise this. A study of a steam table will show how liquefaction may be produced, while the readiness to liquefy is plainly shown on the diagram by a loop or dip on the rising line, by no means always due to valve or piston leakage, though always to be looked at suspiciously, where abnormally low expansion curves are present at the same time.

The Position of the Copper Markets.—Supplementing the remarks made last week on the subject of copper, we should like to accentuate certain facts for the benefit of the consumer. To a great extent users of copper look to America to relieve the tension that exists at the moment, but it must not be forgotten that the United States is increasing enormously in copper consumption, and there are few signs of augmented supplies from anywhere. American production in November last shows a very large falling off, and as present prices offer immense inducements to produce and supply, there is no reason to suppose that there is any accumulation of stocks whatever. It is possible that the figures given at the end of this month will show an increase compared with November, for it is expected that two cargoes of ore may arrive in time to be included in the monthly figures. This, in all likelihood, may lead to a slight set back, but it must not be overlooked that the whole of this copper is already sold and will be taken straightway out of stock by the end of January. Should this set back really occur, it would afford a favourable opportunity for copper consumers to buy. On going to press the price of G.M.Bs. is £57 3s. 9d. for cash and £57 11s. 3d. forward—the highest point touched this year. We understand that in November and December 2,000 tons of American bars were put in stock in Liverpool, thus temporarily swelling the figures, and making a slight increase, but the whole of these bars were sold, and will be all out by the end of February. There is the strongest evidence that present prices are not checking consumption in the least, as a matter of fact it is increasing from day to day, and when one considers the enormous boom in electrical enterprise that is being effected, there is nothing to suggest a lowering in the price of copper unless the supplies are greatly increased. Under the circumstances we should not be surprised to see G.M.Bs up to 60. We believe that not only the electrical industry but also copper producers are inclined to under-estimate the demand for copper that is likely to arise during the next two years in this country. The principal work in electric lighting and traction has yet to be done, and the electrical contracts in hand at the moment will eventually compel large purchases of copper.

The Underground Trolley in a Snowstorm.—The New York underground trolley system underwent the severest test since its inauguration on November 26th and 27th, when the severe snowstorm occurred. The complete or partial paralysis of traffic on some of the lines would seem at first sight to suggest a failure of the underground trolley under such conditions, but a review of all the circumstances shows that the new system lived up to its promises and did as well as could be reasonably expected. The delay in the running of the cars lasted from four hours in the case of some lines to a whole day in the case of others. The *Scientific American* says that the blockade is explained very largely by the fact that such a heavy snowfall as 12 inches was not looked for so early in the season, and the company was to some extent taken unawares, and was not able to concentrate its snow ploughs upon the various lines in sufficient force to keep them all open. Another fact that worked against the system was that the formation of ice on the rails caused the wheels to slip and brought the cars to a standstill. In this connection our contemporary is surprised to note that a New York electrical journal falls into the extraordinary error of stating that the ice on the rails prevented contact between them and the wheels, "thus preventing the establishment of a circuit." It is one of the chief merits of the underground trolley that both the feeder and return lines are placed in the conduit, and the current does not have to pass through the track and the wheels. Slipping of the wheels is a contingency to which every form of motor, whether steam, compressed air, or electric, is liable, and a blockade due to this cause does not reflect in any way upon the underground system as such.

Recognition.—A South African paper says that at the half-yearly meeting of the South African Association of Electrical Engineers lately held in Johannesburg, the president, in the name of the Association, presented Mr. Pask, the secretary, with a gold watch in recognition of the work he had done for the Society.

Another New Engine.—The Dow engine is described in the *Electrical World*, of New York, as the invention of Mr. J. Dow, who was associated with Corliss. Mr. Dow uses two cylinders, side by side, with cranks at 180°, and he makes up the weight of the H.P. piston by means of lead to balance the L.P. piston. The engine is thus a double vertical compound, using steam at 130 lbs., and running at 150 revolutions. The cylinders are placed closely side by side, with short connections, and no receiver, but with direct expansion (on what we are accustomed to consider the Woolf system) from cylinder to cylinder. Thus the H.P. cylinder has in it the full range of temperature from boiler to condenser, and one of the advantages of compound working is sacrificed, viz., the division of the range of temperature between two cylinders. There are four valves for the two cylinders. These are all placed between the cylinders. Steam enters inside the valves from their ends, and escapes outside them. They are all worked by a single wrist plate, and have a cut-off movement actuated from the crosshead, which drives a slotted link, on which is a block controlled by the governor. Indicator diagrams are illustrated for the engine worked both with and without receiver, the latter of which are not the cards one would expect to obtain, the H.P. and L.P. cards being inconsistent. A full description is to be found in the *Proceedings* of the Engineers' Club of Philadelphia. Any advantage of this engine must come from compactness of its cylinders and hardly from its system of working steam, whereby the hot cylinder is exposed to the maximum possible range of temperature. We cannot see that the system of continuous expansion can be justified on thermal reasons, however much it may be excused when the construction of an engine demands it for reasons of simplicity. Mr. Dow looks on a receiver as merely a heat radiator, and it is quite possible to throw away by a badly arranged receiver more than can be saved by its use. Mr. Dow evidently believes in compounding, for what it saves in mechanical stresses, for he uses his first cylinder simply as a measuring pot. He is always sure of a minimum range of expansion, or otherwise he might as well have worked two H.P. cylinders side by side, and while seeking a simple structure have abolished the difference of cylinder diameter, the lead weighted of piston, &c., and possibly two of the four valves.

The Electrolytic Indigo Vat.—There is an important paper on this subject by A. Binz in the *Zeitschrift für Elektrochemie*, V., (1), 5—9, who points out that previous attempts to effect the electrolytic reduction or hydrogeneration of indigotin have not met with much success. The preparation of an indigo vat or the transformation of indigotin into indigo-white, by means of zinc dust and alkali, is usually represented by the equation:—

$$C_{16}\,H_{10}\,N_2\,O_2 + H_2 = C_{16}\,H_{12}\,N_2\,O_2.$$

In confirmation of the results obtained by Goppelsroeder, the author finds that electrolytic hydrogen can, to a limited extent, reduce indigotin to indigo-white. Zinc, however, acts much more rapidly, and he concludes that in the ordinary indigo vat (zinc and alkali) the colouring matter is attacked and transformed directly by the metal itself. A weak vat can be obtained on electrolysis by using a zinc anode, but very soon a point is reached when the sodium indigo-white itself begins to conduct, and this is accompanied by the re-formation of indigotin at the anode, so that the process cannot proceed beyond a certain limit. For practical purposes, therefore, it is necessary to employ a cathode vat which can be separated from the anode compartment by means of a porous diaphragm. But instead of using electrolytic hydrogen as the active agent for the production of an indigo vat, it would seem as if better results could be obtained by liberating zinc directly at the cathode. Since the solution must be alkaline, the proper electrolyte for the purpose is sodium zincate. Details are promised in a future communication.

Search Lights for the Defence of the Thames.—The *Globe* says that orders have been issued for a permanent electric searchlight station to be built on the Sheerness Esplanade, in connection with the scheme for the defences to the Rivers Thames and Medway. The site chosen, about 300 yards from the fortifications, commands the estuary of the two rivers.

The Nernst Lamp.—This lamp, the general nature of which we have described more than once, was recently noticed in the *Frankfurter Zeitung*, which illustrated some new arrangements. As our readers will be aware, the source of light in the Nernst lamp is a rod of magnesia, rendered incandescent by the passage of an electric current. Before, however, the current can pass, the resistance of the magnesia must be reduced by heating it from an external source of heat. One of the arrangements for carrying this out is shown in fig. 1. The magnesia, A, is placed in the focus of a reflector, C, on the inner side of which is a spiral wire of platinum, D, which, when brought to incandescence by a

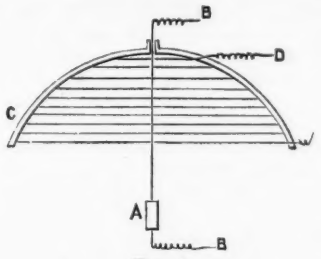


FIG. 1.

current, produces heat sufficient to render the magnesia a conductor. A current is then passed directly through the oxide by the wire, B, and the current in the spiral is shut off. A more complicated form of the lamp is shown in fig. 2.

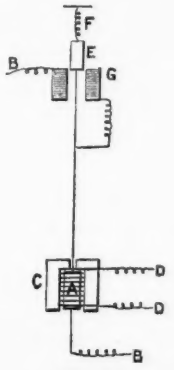
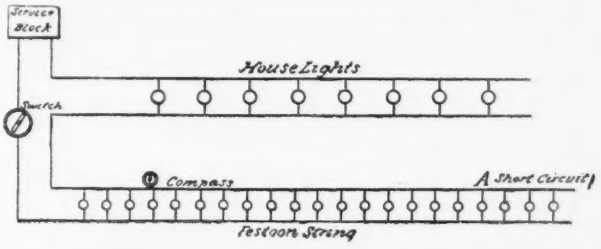


FIG. 2.

Here the magnesia, A, is placed within a cylinder, C, which also encloses a platinum spiral, D. As soon as the incandescent spiral has heated the magnesia sufficiently, a current is passed through the oxide by the wire, B. In this circuit is a solenoid, G, which, on being energised, draws down the iron core, E, and lowers the now incandescent magnesia out of the cylinder. When the current is switched off, the pull of the solenoid stops, and a spring, F, raises the iron bar and magnesia to their former positions. Prof. Nernst claims that his lamp gives the same amount of light as the ordinary incandescent at one-third the cost; the light is purer, and no vacuum tube is required.

Degrees in Demand!—The *New York Journal of Commerce* has the following very amusing item of information:—"A gentleman in Philadelphia has received from a firm in Rio de Janeiro an inquiry for some person or institution that would supply degrees in medicine, law, dentistry and civil engineering, with information as to prices. The practice of these professions in Brazil requires a diploma or a degree, and those of foreign institutions are accepted. It appears that there are in Brazil many gentlemen who desire to practice these professions, but have not studied them, and do not care to spend the time and money necessary for acquiring a knowledge of them. Much as we are interested in seeing the export trade increase, we should be sorry to learn that an item among our shipments to Brazil consisted of literary degrees or professional diplomas."

One Way for Finding a Short Circuit.—Mr. A. E. Dobbs, in the New York *Electrical Engineer* says:—"In constructing the strings of electric lights which were festooned across the streets of Chicago during the Peace Jubilee of October 16—18th, the strings consisting of 100 lights each were made up in a long basement cellar. It would happen occasionally that a socket would be found that short circuited the string. An examination of the sockets did not always reveal the cause of the trouble, and at first it was thought that the socket could be burnt out by throwing



current from the street mains into the string, but after blowing out two or three 150-ampere fuses that plan was abandoned. Then one of the wiremen got an idea, hunted up a pocket compass and connected up the line, as shown in the figure. A circuit of eight house lights was detached on one side from the service block and connected through the loop made by the short circuit. The compass was then slid along over the string, the needle giving a wide deflection till the short-circuited socket was reached (A), when it stopped and swung back to its normal position. This plan is simple, cheap, convenient and applicable in many cases."

Extraction of Gold and the Cyanide Process.—In a *résumé* of the cyanide process by T. K. Rose, in *Science Progress*, 1898, 7, 307—318, the author discusses the fact that solution of the gold does not take place in the absence of oxygen or an oxidising agent. It is doubtful whether the efficiency of ferric chloride and halogens is due to their oxidising power or to their direct affinity for potassium. In most cases with tailings poor with gold and free from sulphides, the air entangled in the ore is sufficient, whilst with ordinary pyritic tailings oxygen is generally supplied by "doubled treatment," aeration taking place during the draining off of the first solution. The most difficult materials to treat are slimes containing ferrous sulphide, which results from the decomposition of pyrites during the accumulation of the slimes. These slimes must be thoroughly oxidised by mechanical aeration, and, if necessary, by permanganate of potash. On the other hand, an abundance of oxygen means a large destruction of cyanide, and judgment must be used to obtain the most economical result. The author discusses the subject of dilution, pointing out that a dilute solution is just as efficient as a strong one if the supply of oxygen be not increased as well as the concentration. With slimy ores, which, owing to mechanical difficulties, require prolonged treatment, there is no necessity to hasten the solution of the gold, and it is better to use a dilute cyanide solution which suffers less waste than a strong one. The objection formerly raised, that the gold could not be entirely recovered from a dilute cyanide solution by means of zinc, has been overcome by using the zinc in threads with a very large surface and by prolonged contact. The electrical processes for the precipitation of the gold have been of immense benefit in the treatment of very dilute solutions, but the electrodes must be large and very close together to overcome the great resistance of the dilute liquid. Anodes of iron or lead peroxide and cathodes of sheet lead are used, and it is best to have a slight excess of potassium cyanide present to prevent the precipitation of gold cyanide along with the Prussian-blue produced. Very clayey slimes have recently been successfully treated by circulation as a pulp with very dilute cyanide solution through a centrifugal pump with admission of air, and subsequent settling in large vats, and filtration of the decanted liquid through sand. The solution must be absolutely clear, and a low current density of not more than 0·04 ampere per square foot should be used.

Hill Climbing Motor Car Tests.—The hill-climbing tests of the French Automobile Club took place on November 27th, and appear to demonstrate very considerable capacity on the part of many of the vehicles. The hill surmounted was that at Chanteloup, near Paris, the slope of which varies up to 11 per cent., or nearly so, or, as we should say, 1 in 9. The length of the hill is 1,800 km.—a distance covered in 3 minutes 52 seconds by the winner, M. Jenatzy, with an electric carriage. The battery was very powerful. The total weight of car was 1,800 k., and over 28 H.P. was developed in places, which seems enormous, and Mr. Farman, to whose account in *Industries* we are indebted for the figures, considers any longer duration would have completely disabled the batteries, whereas petroleum cars would have gone on all right. Eleven of the contestants did the journey under 5 minutes, the remainder tailing off to a maximum of nearly 23 minutes. The second vehicle required only 10 seconds longer than the electrical car. It was a single-seat Bollée Voiturette, and had a motor of 8 H.P. The speed of the winner was nearly an average of 30 km. per hour—a most respectable performance, as, indeed, were all the runs under 5 minutes, for they represent speeds of above 21 km. per hour, or about 14 miles. If autocars will run at this speed up grades of from 3 to 10 per cent. with motive power of reasonable dimensions, the future of such cars must be good. There were 45 vehicles in the competition, and over 200 vehicles present in all. Mr. Farman is himself a petroleum vehicle man, and may be biassed against the electrical vehicle, which he affirms would have been disabled by an hour's similar contest. It must, of course, be some time before electrical vehicles can have so wide a range as petroleum cars, the success of which will not have a retarding effect on electrical cars, but, on the contrary, will tend to their extension and will assist to familiarise the public with motor cars generally.

The Action of the Silent Electric Discharge on Liquid Dielectrics.—Marcellin P. E. Berthelot describes in the *Comptes Rendus* (*vide* Vol. cxxvi., page 691), some experiments carried out in order to determine the action of the silent electric discharge on liquid dielectrics. Dry terebenthene, when subjected to the action of the silent electric discharge, yields a small quantity of diterebenthene, but otherwise remains unaltered. Olive oil yields a small quantity of a blackish product insoluble in ether, oil, and all the various solvents. Except for the difference in colour, it resembles the polymeride formed in presence of nitrogen. Alcohol, when the action is prolonged, yields hydrogen and ethane, and the liquid contains some aldehyde and a hydrocarbon which seemingly contains less hydrogen than the olefines, and has a feeble action on ammoniacal silver nitrate.

A Successful German Lighting Station.—The annual meeting of the shareholders in the Berliner Electricitäts Werke took place on October 31st last. The results of the operations of the lighting plant for the year 1897-8 permitted a dividend of 13 per cent. to be paid, as against 12½ per cent. in the previous year. During the first quarter of the current year the daily consumption of electrical energy for lighting or other purposes was increased by 1,000 kw., and orders for connections equal to 1,460 kw. are in hand. The question of the transfer of the works to the city authorities is still unsettled, owing to disagreement as to the terms of purchase. Mr. John S. Raworth would doubtless argue that the consumers would benefit if it remained unsettled for an indefinite period, but the worthy shopkeepers and other consumers of Berlin no doubt think that a portion of the 13 per cent. dividend may be transferred to their own pockets by a judicious purchase scheme and wise management of the works afterwards, and we cannot say that we altogether disagree with this opinion.

Diathermancy of Various Insulating Materials.—An interesting comparison of the insulating action of various materials has been instituted by Prof. Carpenter, says the *Schweizerische Bau Zeitung*. If the loss of heat of a non-enclosed pipe is taken as 1, the following rotation of figures is obtained for the effect of the insulating agents:—Pale gray lead paint coat, 1·267; asphalt coat, 1·135; two layers of asbestos paper, 0·777; one layer of asbestos board, 0·594; four layers of asbestos board, 0·503; a wooden pipe, 0·320; magnesia, applied as paste, 0·224; slag wool, felty, 0·209; asbestos, mixed with felt, 0·208; slag wool, fibrous, 0·203; asbestos with sponge, 0·180; two layers of asbestos paper, 2·5 millimetres felt, 0·170. Consequently, the escape of heat seems to be increased by lead paints and asphalt paint. Remarkable is the slight increase in the imperviousness in using four layers of asbestos board, as compared with the results obtained by the use of only one layer.—*Scientific American.*

Researches on the Variations of Spectra in Magnetic Fields.—In the *Comptes Rendus* (*vide* Vol. cxxvi., page 997) Messrs. Henri Becquerel and Henri Deslandres describe some researches, the object of which was to extend the observations of Lorentz and Zeeman, Cornu and Michelson on the variations observed in spectra when the luminous bodies are within a strong magnetic field. They find that, under the influence of the field, a line may be split up in such a way that components polarised in a plane perpendicularly to the field enclose the components polarised in a plane parallel with the field, this being a mode of division which was not described by Michelson, and which is contrary to that usually observed. Special attention was given to the spectrum of iron, and the following table shows the influence of the magnetic field on a portion of the spectrum between λ 387 and λ 382.

Differences of Wave-Length in the Magnetic Field. Lines Polarised in a Plane.

Normal wave-lengths.	Normal to the field.	Parallel with the field.
3,872 61	0·207	0·383
3,865 65	0 368	0
3,860 03	0	0·369
3,858 40 (Ni)	0	0·293
3,856·49	0	0·355
3,850·10	0	0
3,841·19	0	0·184
3,840 58	0	0·159
3 834 37	0	0·230
3,824 58	0	0·360
3,820·64	0	0 287

It is noteworthy that the line, 3,850·10, does not become multiplied, although the neighbouring lines show the phenomenon. The line, 3,865 65, is resolved into a triplet, but, unlike other lines, it shows a distinct sub-division in the spectrum polarised in a plant normal to the field, and a slight thickening in the spectrum polarised in a plane parallel with the field. These peculiarities show that a magnetic field may render evident differences as yet unobserved between the lines of one and the same element or between lines of the same spectrum, and the authors suggest that some of the spectral lines not hitherto recognised as belonging to any particular substance may really be due to the effects of magnetic influence. The carbon band at λ 388 found in the spectra of the sun and of comets, and remarkable for the number and regular order of its component lines, shows no recognisable splitting up or enlargement of the lines in a magnetic field, although the calcium lines, under the same conditions, show the usual sub-division. Zeeman found no alteration in the bands of iodine. All the observations hitherto made seem to show that the influence of the magnetic field is greatest in the case of lines of high wave length.

Employers' Parliamentary Council.—A council has been formed representing the employers' associations of the United Kingdom, with the intention of watching the introduction into the House of all Bills affecting employers. Anything more ridiculous than the latest Employers' Liability Act of the present Government it would be difficult to conceive. The mischief ought to be repaired, and we hope the Parliamentary Council will take the matter in hand, as well as try to prevent any such future errors.

Electric Haulage on Canals.—It has been definitely decided to establish a system of electric haulage on the canal between Brussels and Seneffe.

Chemical Equilibrium and Electromotive Force.—In the galvanic chain, thallium in thallium chloride, potassium chloride, potassium thiocyanate, thallium in thallium thiocyanate, the reaction may be represented by $T_1 Cl + SCN' = Cl' + T_1 SCN$, and if the ratio of the equilibrium concentrations of chlorine and thiocyanate ions $= k$, and the ratio of these ions actually present $= a$, then the electromotive force is given by the expression $= RT/F \log. k/a$. From determinations of the E.M.F., therefore, the ratio of the equilibrium concentrations may be calculated. The values so obtained were compared with those obtained chemically, the numbers being:—

Temperature.	Electrically found ratios.		Chemically found ratio.
39·9°	0·87	0·88	0·85
20·0	1·27	1·25	1·24
0·8	1·77	1·82	1·74

The above reaction is attended with the heat development of + 31·8 K, and from this the temperature coefficient of the equilibrium constant may be deduced by the expression $\log. K - \log. K = q/R\ (1\ T - 1\ T)$, and the temperature coefficient of the E.M.F. by the expression $(-q)\ T = d/d\ T$. The values K/K and K/K so obtained agree well with the chemically found values, and the temperature at which $K = 1$ is found to be (1) 31·2°, (2) 32·5°, whilst the temperature at which the change in direction of the current occurs agrees well with the found temperature in each of the galvanic chains examined. The above is an abstract of a paper by Carl Knupffer in the *Zeitschrift für Physikalische Chemie*, 1898, 26, 255—285.

Physical Changes Induced by Light.—The physical changes caused by light may be divided into changes in the relative position of (1) the atoms, (2) the molecules. Examples of the first class are collected, and show that the general nature of the change is from a maleinoid to a fumaroid form, the original compound possessing in all cases the greater solubility and lower boiling and melting points. The second class of changes are those of polymerisation, in which, however, the actual formation of double or multiple molecules is not necessary, but only a greater volume concentration of molecules. In all cases, and a large number of examples are adduced, the polymeride is distinguished from the monomeride by (1) smaller vapour pressure, (2) higher melting and boiling points, (3) smaller solubility, (4) lower specific heat; its formation is always exothermic, and by increase of temperature it is again converted to the monomeride. In changes induced in organic compounds it is noticeable that the change is always associated with a double or treble linking, and Max Roloff considers that the action of light cannot be regarded as a mere mechanical disturbance of the molecule, but that the explanation must be sought in the influence of electro-magnetic waves on axes of electrical polarity of the molecules. Luminescence is frequently associated with the polymerisation and the reverse change, and both phosphorescence and fluorescence appear to be due to the formation of polymerides, which are re-converted to the monomerides with luminescence. The crystal colourations are probably due to similar causes, and in the case of sodium and potassium chloride, are connected with the production of trivalent chloride. In many cases the phenomena occur best in the presence of small quantitites of impurities, and the author considers the effect of the latter to be that of a "sensitiser," but full consideration is postponed. The above is an abstract of a paper by Max Roloff in the *Zeitschrift für Physikalische Chemie*, 1898, 26, 337—361.

NEW COMPANIES REGISTERED.

A.B.C. Electric Arc Lamp and Incandescent Mantle Company, Limited (59,963).—This company was registered on December 19th, with a capital of £60,000 in £1 shares, to acquire, own, and work certain patents and rights relating to electric lighting, to adopt an agreement with Ferdinand Fanta, and to carry on the business of electrical engineers and contractors, electric] lamp and fittings manufacturers, &c. The first subscribers (each with one share) are:—Walter H. Phillips, 18, Kennington Park Road, S.E., electrical wireman; Edgar C. Bowtell, 39, Brooke Road, N., clerk; Joseph C. Coates, 202, Gascoigne Road, Barking, E., clerk; C. R. Thorpe, 3, Trinity Road, Wood Green, N., clerk; H. M. Merrill, Manchester Street, Brighton, accountant; W. Herbert, 1, Lombard Court, E.C., accountant; B. F. Ball, 113, Avenell Road, Highbury, clerk. The first directors (to number not less than three nor more than seven) are to be nominated by the subscribers; qualification, £50. Registered office, 97, Queen Victoria Street, London, E.C.

Pearson Fire Alarm Indicator, Limited (59,967).—This company was registered on December 19th, with a capital of £150,000 in £1 shares, to acquire the benefit of three inventions known as the Pearson Automatic Fire Indicator, the Pearson Automatic Box Telegraph Fire Alarm Indicator, and the Pearson Automatic Railway Signal, to adopt an agreement with Henry Gamman and Richard Pearson, and to carry on the business of mechanical and electrical engineers, iron and brass founders, and manufacturers of and dealers in fire indicators, fire extinguishers, fire engines, agricultural implements, tools, &c. The first subscribers (each with one share) are:—H. Gamman, Woldingham Dene, Surrey, gentleman: R. Pearson, 100, St Martin's Lane, W.C., electrician; C. Beadle, Belvedere, Kent, merchant; A. J. H. Wills, 53, Holborn Viaduct, E.C., gentleman; C. F. Torrey, 108, Fenchurch Street, E.C., steamship manager; C. Fane, 98, Leadenhall Street, E.C., engineer; L. Nevill, 25, Old Broad Street, E.C., solicitor. The number of directors is not to be less than three nor more than seven; the first are the Hon. Lionel Holland, Henry Gamman, and Richard Pearson; qualification, £1,000; remuneration, £100 each per annum, and £150 for the chairman.

Kidderminster and District Electric Lighting and Traction Company, Limited (59,972).—This company was registered on December 19th, with a capital of £100,000 in £10 shares (5,000 preference), to carry on the business of electrical engineers and contractors, electricians, suppliers of electricity, electrical apparatus manufacturers, mechanical and chemical engineers, tramway and light railway proprietors, carriers, &c. The first subscribers (each with one share) are:—Emile Garcke, managing director; George Stevens, secretary; Charles H. Dade, assistant secretary; Charles H. Gadsby, contract engineer; W. Howard Smith, engineer; C. Walmsley, accountant; and Henry M. Sayers, power engineer; all of Donnington House, Norfolk Street, W.C., and all connected with the British Electric Traction Company, Limited. The number of directors is not to be less than three nor more than five. The subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company. Registered office, Donnington House, Norfolk Street, Strand, W.C.

Buck & Co., Limited (60,005).—This company was registered on December 20th, with a capital of £2,000 in £1 shares (1,000 £5 per cent. cumulative preference), to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, motor car builders, metal workers, &c. The first subscribers (each with one share) are:—Harry T. Underwood, Brentford House, Brentford, merchant; John H. Bailey, White Stile Road, Brentford, clerk; W. R. Whitehead, 278, High Street, Brentford, clerk; W. G. Brown, 7, White Stile Road, Brentford, clerk; Mrs. Catherine J. Buck, and Albert G. R. Buck, electrical engineer, of 18, Thornton Avenue, Chiswick; Ernest A. Hill, 17, St. George's Terrace, Gloucester Road, S.W., electrical engineer. The first directors (to number not less than two nor more than five) are Harry T. Underwood and Albert G. R. Buck; qualification, £100; remuneration as the company may determine.

"Hart" Accumulator Company, Limited (60,059).—This company was registered on December 23rd, with a capital of £40,000 in £1 shares, to acquire the business of the Hart Secondary Battery Syndicate, Limited, carried on at Stratford, West Ham, to adopt an agreement with the Hart Secondary Battery Syndicate, Limited, Samuel W. Hart and Edward J. Clark, and to carry on the business of an Electric Lighting, Heating and Power Company. The first subscribers (each with one share) are:—S. W. Hart, Oakdene, South Woodford, gentleman; George A. Bacon, Addison House, Muswell Hill, N., gentleman; John G. Abraham, Grove Lodge, Muswell Hill, N., surveyor; George B. Kidd, 229, Romford Road, Forest Gate, licensed victualler; Leslie W. Spratt, 369, Romford Road, Forest Gate, draper; George Hay, The Chestnuts, Stratford, E., confectioner; Ernest H. White, 127, Portsdown Road, Maida Vale, W., clerk. The first directors (to number not less than three nor more than five) are to be nominated by the subscribers; qualification, £500; remuneration, £500 per annum divisible. Registered office, 75, Coleman Street, E.C.

Aberdeen Electrical Company, Limited (4,095).—This company was registered in Edinburgh on December 21st, with a capital of £10,000 in £1 shares, to acquire and carry on the business of an electrical engineer now carried on by Richard G. Botting, at Aberdeen. The first subscribers (each with one share) are:—John Edwards, 58, Bridge Street, Aberdeen, wholesale merchant; George England, 8, Bridge Street, Aberdeen, wholesale merchant; George Rainst and John McBain, 38, Union Street, Aberdeen, chartered accountants; Wm. Ironside, C.C., 3, Golden Square, Aberdeen; A. Ledingham, 16, Bridge Street, Aberdeen, solicitor; R. G. Botting, 51, School Hill, Aberdeen, engineer. The first directors (to number not less than three nor more than seven) are John Edwards, George England, Wm. Ironside, and Alex. Ledingham; qualification, 100 shares; remuneration as fixed by the company. Registered office, 51, School Hill, Aberdeen

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Crystal Electric Lamp and Rose & Bird, Limited (58,218).—This company's statutory return was filed on December 6th. The capital is £50,000 in £1 shares (10,000 preference). 39,750 ordinary and 6,000 preference have been taken up, and 39,743 of the ordinary and 1,000 preference are considered as fully paid; £1 per share has been called on 7 ordinary and 5,000 preference, and £5,000 has been paid, leaving £7 in arrears.

A. Hirst & Son, Limited (57,889), Electrical engineers of Dewsbury.—This company's statutory return was filed on October 19th. The capital is £5,000 in £10 shares (100 preference); 300 ordinary have been taken up and issued as fully paid, while 80 preference shares have been subscribed for and paid in full.

Alliance Electrical Company, Limited (57,770).—This company's statutory return was filed on November 3rd, when 7 shares were taken up out of a capital of £1,000 in £1 shares and paid for in full.

CITY NOTES.

Douglas Southern Electric Tramways, Limited.

The report of the directors of the Douglas Southern Electric Tramways, Limited, for the year ended October 31st last, to be submitted to the third annual meeting to be held at Manchester on Tuesday, states that the duration of the season was 132 days, and the total miles run amounted to 40,963, and 94,173 passengers were carried. The gross traffic receipts amounted to £4,136, from which is deducted £689, tolls payable to the Douglas Head Marine Drive, Limited, leaving net passenger receipts £3,446, to which is added sundry discounts, &c., £11, bringing the total net receipts to £3,458. The directors regret that the receipts were not much larger, but unfortunately, with the exception of the first Monday in August (Bank Holiday), the Easter, Whitsuntide, and August holiday weeks were marked by rain and stormy weather, and consequently proved unremunerative. The daily service was well maintained thoughout the season, and no accidents to life, limb, or rolling stock occurred. The directors have written off the whole of the formation expenses—£600, and also a sum of £300. The latter sum represents the damages paid to the Douglas Head Marine Drive through failure to complete the works and keep the line open during the season of 1896. It was thought this account would be recoverable from the contractors, and it appeared in last year's accounts as an asset, but upon going into the matter, it was deemed advisable not to press the claim. The Board have, therefore, charged both this, and the formation expenses (£600) to this year's profit and loss account, thinking it much wiser to write off these items, as they do not represent tangible assets, and, consequently, future balance-sheets will not be handicapped by them. The line and property have been kept in a thorough state of repair, and the sum of £303 has been spent out of this year's revenue in improving and repairing the permanent way. Notwithstanding these heavy charges against revenue, amounting to £1,203, there is a balance, being profit for the year, of £91, which, being added to £260, brought forward from 1897, leaves a balance of £351. All accounts against the company have been paid, and it will commence the new season free from debt, and with a balance in hand. Although no dividend will be recommended this year, it is hoped that by clearing the above obligations out of the accounts there will be every hope next year of a full dividend upon the preference shares, and, if the season is a fine one, there will be a good chance of there being a balance left over for the ordinary shareholders.

Smithfield Markets Electric Supply Company.

The first ordinary general meeting of the Smithfield Markets Electric Supply Company, Limited, was held at Winchester House last Friday, Mr J. Browne Martin in the chair.

The Chairman thought that it would be known to most of them that something like a year ago this company purchased the undertaking of the Smithfield Electric Construction Company. When the present company came into possession they found that the machinery, and every appliance in connection with it, had had a good deal of wear, and had not been kept up to date. They therefore at once set to work to put their house into order. They employed the services of a very eminent engineer, Mr. Cooper, and acting on his advice, they at once commenced to overhaul the machinery, and to supplement it where necessary. They had also decided to put accumulators in, which would effect a saving of something like £500 a year. He was pleased to mention that nearly every shop in the new fish market had now been connected, and they had received instructions from the Corporation for the lighting of the old fish market, which would be reopened as a meat market early next year. This would considerably increase the output of the company. They would know that when they first took over this business there was an arrangement which had been made by the old company to supply electricity in what was termed a lump sum. That meant that any customer who was willing to pay a certain sum a year had electricity supplied, whether in large or small quantities, for that sum. It would be evident to everybody that in that case there would not be the care and supervision in using electricity that consumers would exercise when they had to pay by meter. The company, therefore, decided that they must supply in the ordinary way by meter. At the same time, they were very careful not to rub up their customers too much. In making a change of this kind there was always a good deal of criticism. With all their care, attention and courtesy, they lost a large number of customers in the first place, but he was pleased to say that those gentlemen who left them had not only come back, but in several cases had induced persons who were not customers before to take the current from this company. Possibly some people might say that they expected this company to go on much quicker than they had done, but they had been treading on delicate ground and thus altering the method of supply, and had to be careful The building of the cold air store, which was delayed a considerable time, owing to certain constructional difficulties and arrangements with the County Council and other bodies, was now well forward, and the minimum rental of £1,500 a year commenced last June. The company had applied for several provisional orders, and he thought that there was no doubt that they stood a fair chance of getting one or more of them. The citizens of London must feel that if there was to be a second company introduced into the City, this company should get the preference over any other. They were the only company, excepting the City of London Electric Lighting Company, that held any order in the City, and it appeared to them that it was only natural that if the City had had pressure put upon them by the Board of Trade and other authorities to grant an order to a competing company they would give this company what influence they could in support of their efforts to get the requisite powers. Over and above the City, they had applied for the Holborn and St. Luke's districts, which were both exceedingly valuable electric lighting areas. His colleague (Mr. Schenck) and himself were very confident that the company would ultimately be of very much larger dimensions than it was now. They were neither of them new to the electric lighting industry, and the companies that he was on now that commenced in a very small way were now very large. There was a lot more that he would like to tell them, but in the interests of the company of which they were all proprietors they would see that it was not always advisable to give the show away. He moved the adoption of the report and accounts.

Mr. Ernest Schenck seconded the motion, and in the discussion which ensued Mr. Cox inferred that for the new undertakings at which the chairman had hinted large additional capital would be needed.

The Chairman replied that with their present large plant they could do much additional work without fresh capital.

The motion was afterwards carried.

Automatic Telephone Company, Limited.—The annual general meeting of this company was held last Friday at Winchester House under the presidency of Mr. Max Margowski. After some lengthy remarks from the chairman, a long and personal discussion ensued, and at the close of the meeting there seemed to be some doubt as to whether the report had been rejected or accepted.

Cape Electric Tramways, Limited.—An interim dividend of 3 per cent., free of tax, has been declared.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending December 24th, 1898, were £132 15s.; aggregate to date, £14,259.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending December 23rd, 1898, were £2,729 15s. 7d.; corresponding period, 1897, £2,736 9s. 7d.; increase, £3 6s.

The City and South London Railway Company.—The receipts for the week ending December 25th, 1898, were £1,134; week ending December 26th, 1897, £1,055; increase, £79; total receipts for half-year, 1898, £25,968; corresponding period, 1897, £25,117; increase, £851. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending December 24th, 1898, were £146 7s. 8d.; week ending December 25th, 1897, £87 12s. 8d.; increase, £59 15s.; total receipts to date, 1898, £8,355 10s. 6d. Miles of track open week ending December 24th, 1898, 3; week ending December 25th, 1897, 3. Car miles run week ending December 24th, 1898, 4,312; week ending December 25th, 1897, 2,086. Number of cars week ending December 24th, 1898, 11; week ending December 25th, 1897, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, December 23rd, 1898, were as follows:—D. U. T. Co., horse cars, £2,495 17s. 9d.; ditto, electric cars, £389 10s. 6d.; D. S. D. Co., electric cars, £663 15s. 3d.; total, £3,499 8s. 6d; corresponding week last year—D. U. T. Co., horse cars, £2 862 3s. 5d.; ditto, electric cars, £125 6s. 6d.; D. S. D. Co., electric cars, £400 5s. 1d.; total, £3,387 15s.; increase, £111 8s. 6d.; aggregate to date, £98,762 4s. 8d.; aggregate to date last year, £91,650 1½s. 10d.; increase to date, £7,111 11s. 10d. Worked:—The mileage open is 16 miles electrically, 28 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending December 25th, 1898, amounted to £1,439; corresponding week last year, £1,341; increase, £98.

The South Staffordshire Tramways Company.—The receipts for the week ending December 23rd, 1898, were £685 8s. 7d.; week ending December 24th, 1897, £664 6s. 5d.; aggregate receipts for 51 weeks, £32,188 6s. 3d.; last year, £32,205 9s. 11d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Dec. 21st.	Closing Quotation, Dec. 28th.	Business done during week ended Dec. 28th, 1898. Highest.	Lowest.
127,400£	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	101 —105	101 —105	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
905,560£	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	65 — 67	...	...
3,047,220£	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	115 —116	116 —117	116½	115
3,047,220£	Do. do. Deferred...	Stock	...	...	...	16 — 16½	16¾— 17½	17 5/16	16 7/16
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¼— 15¾	15¼— 15¾	15⅜	...
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	111 —115	111 —115	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3½	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105⅛	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 1/8	1/16— 1/8	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	10 — 11	10 — 11	10 7/16	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	16½— 17½	16½— 17½	...	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	105 —108%	105 —108%	...	...
60,710£	Direct United States Cable	20	2½ %	2½ %	...	11½— 12	11¾— 12¼	...	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	103 —106	103 —106	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	173 —178	173 —178	175½	174
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	104 —107	104 —107	105½	104½
500,000	Do. Prov. Certs., 50 % paid	...	...	...	...	54 — 57	54 — 57	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	5 %	101 —104	101 —104	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	124 —128	124 —128	124	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17 9/16	17 9/16
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	101 —105	101 —105	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —129	125 —129	...	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	101 —105	101 —105	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	104 —106	104 —107	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	104 —107%	104 —107	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	12½— 12⅝	12½— 12⅝	12½	12 5/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	16⅞	16¾
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	28½— 29½	...	...
150,000£	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,800	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	101 —104	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	55 — 58	55 —58	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5½— 5⅝	5½— 5⅝	5⅝	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	13 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½— 5½	5⅝— 5⅝	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —103	100 —103	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	134 —139	134 —139	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4½— 4⅝	4½— 4⅝	...	...
151,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	5 %	5 %	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	12½— 12⅝	12½— 12⅝	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½ %	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	107 —110	107 —110	...	...
88,321	West India and Panama Telegraph	10	⅞ %	1 %	⅞ %	1⅝— 1⅞xd	2 — 2¼	2⅛	1⅞
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	10 — 10½xd	10¼— 10¾	10¾	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	8½— 9½xd	8½— 9	9⅛	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	106 —109	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	6 %	98 —103	98 —103	101½	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	11½— 12½	11½— 12½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	5 %	6 %	9 — 10	9 — 10	9⅛	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	113 —115 xd	113 —115	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	22 — 24	23 — 24	23½	22¾
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	21 — 23	21 — 23	22¾	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	15⅞	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	127 — 132	127 —132	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	12½— 13½	12½— 13½	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £8 paid.	10	...	...	...	10 — 11	10 — 11	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14½— 15½	14½— 15½	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5 — 5½	...	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	...	4 %	9 — 10	9 — 10	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	9½— 10½	9½— 10½	9 1/16	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3 — 3½	3 — 3½	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6 — 6½	6 — 6½	6 7/16	6 5/16
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17½— 18½	17½— 18½	17⅝	17½
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	17 — 18	17 — 18	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	16 — 17	16 — 17	16¾	16¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	105 —108	105 —108	...	...
65,000	South London Electricity Supply, Ord., £3 paid ...	5	...	...	...	2¾— 3	2¾— 3	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	15½— 16½	15½— 16½	...	...

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Dec. 21st.	Closing Quotation Dec. 28th.	Business done during week ended Dec. 28th, 1898. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3¼— 3⅜	3¼— 3⅜	3½	3 7/16
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	99	98¼
30,000	British Electric Traction	10	...	...	...	15½— 16½	15½— 16½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 13½	13 — 13½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1⅝— 1⅞	1⅝— 1⅞	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	104½	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	9½— 10½	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —115	112 —115	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	10⅛	...
178,303	Do. do. do. £6 paid	10	...	...	...	5½— 6½	5½— 6½	...	..
61,033	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4⅜	4¼— 4⅜	...	...
630,000*l*	City and South London Railway	Stock	1 1/16 %	1 1/16 %	1⅛ %	65 — 68	65 — 68	67½	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £4 pd.	10	...	...	...	3½— 4	3½— 4	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1¾— 2¼	1¾— 2¼	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	91 — 96	91 — 96	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½ %	6 %	2½— 2⅝	2½— 2⅝	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½ %	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99xd	97 — 99	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2½— 2⅝	2½— 2⅝	2 5/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	2⅝— 3¼	2⅝— 3¼	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ½	¼— ½	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	21½— 22½	22 — 23	22½	22⅜
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	4½ %	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	102½	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅝%	2⅞%	3¼%	10 1/16— 10 3/16	10 — 10¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14¾— 15¼	14¾— 15¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	40	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	111 —114	111 —114	...	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10¼.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—13.
House-to-House, 4½% Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7⅛—8. Debentures, 107—109. Dividend, 1897, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, ⅜ to ½.
Smithfield Market Electric, 3½—4.
*T. Parker, £10 (fully paid), 15½.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (October 13th, 1898).

MARKET QUOTATIONS, Wednesday, December 28th.

CHEMICALS, &c.	Last week.	This week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	22/-	22/-	..
a " Oxalic .. .. .. per cwt.	32/-	32/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per ton	£7/-	£7/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a " (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£19 10	£19 10	..
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a " White Sugar .. .. per ton	£30 10	£30 10	..
a " Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a " Caustic (75/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. .. per cwt.	65/-	65/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a " Recovered .. .. per ton	£5 15	£5 15	..
a " Lump .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a " Crystals .. .. .. per ton	£3	£3	..
a " Bichromate, casks .. per lb.	3d.	3d.	..

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£294	£294	..
b " Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2" to 12") basis per lb.	6¾d.	6¾d.	..
c " Tube (brazed) .. .. per lb.	8¼d.	8¼d.	..
c " Wire, basis .. .. per lb.	7d.	7d.	..
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£66	£66	..
g " Wire (basis price) .. per lb.	8d.	8d.	..
g " Sheet .. .. .. per ton	£66	£66	..
g " Rod .. .. .. per ton	£66	£66	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	none obt'le
h India-rubber, Para fine .. .. per lb.	4/ n. 4/1½ o.	3/11½ forw'd	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i " Pig (Cleveland warrants) per ton	44/8	44/3	..
i " Forgings, according to size per ton	From £11	From £11	..
i " Scrap, heavy .. .. per ton	45/-	45/-	..
i " Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£13 5	£13 5	..
g " Sheet .. .. per ton	£14 3 9	£14 3 9	..
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. ..per bottle	£7 15	£7 15	..
o Platinum .. .. per oz.	£3 1 6	£3 1 6	..
i Steel, Magnet, according to description .. .. .. per ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£87 10	£85 10	£2 inc.
g " foil .. .. per lb.	1/3	1/3	..
n " wire Nos. 1 to 16 .. .. per lb.	1/4	1/4	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
j " Flax, 6 or 8 lea... .. per lb.	8½d.	8½d.	..
j " Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j " " Russian, 10 lbs. per lb.	4½d.	4½d.	..
j " Jute, 180 lbs. rove .. per ton	£12	£12	..
j " Manila, 24 thread .. per ton	£29	£29	..
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£29 10	£29 10	..

a Quotations supplied by Messrs. G. Boor & Co.
b " " " The British Aluminium Co., Ltd
c " " " Messrs. Thos. Bolton & Sons.
d " " "
e " " "
f " " " The India-Rubber, G.-P., and Teleg. Works Co Ltd
g " " " Messrs. James & Shakspeare.
h " " " " Jackson & Till.

i Quotations supplied by Messrs. Bolling & Lowe.
j " " " " Henry C. Yeo & Co.
k " " " " Morris Ashby, Limited.
l " " " " Sanders, Wake & Co.
m " " " " W. T. Glover & Co., Ltd.
n " " " " P. Ormiston & Sons.
o " " " " Johnson, Matthey & Co., Ltd

INSTITUTION OF ELECTRICAL ENGINEERS.

"Electric Intercommunication in Railway Trains." By W. E. Langdon, Vice-President. Paper read December 15th, 1898.

(*Continued from page* 956.)

We have now before us the various electrical "systems" calling for criticism, and the first question which will present itself for consideration is whether a one or a two insulated wire system is to be preferred.

We have seen, from the experience of the London, Brighton and South Coast Railway, that an earth or rail return is not satisfactory.

FIG. 6.

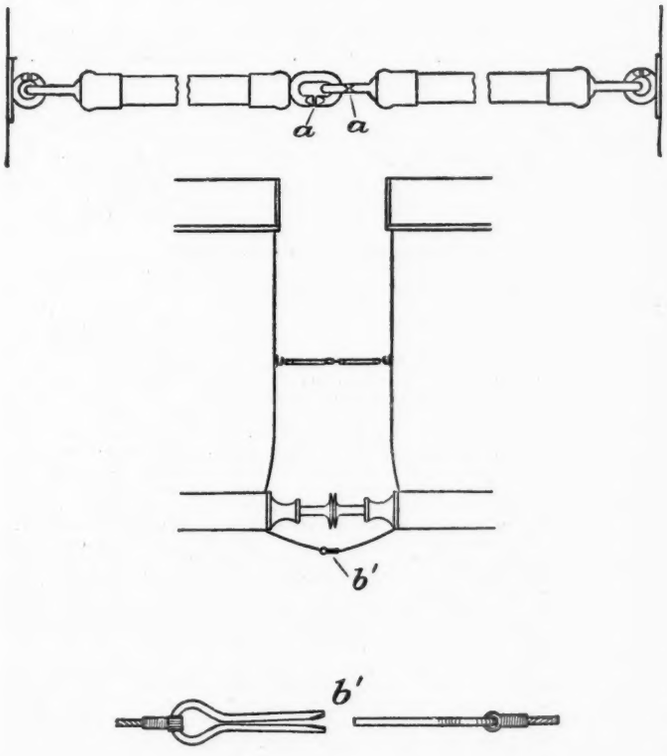


FIG. 7.

It will also be clear that with an open—*i.e.*, an uninsulated—return, any leakage which may arise in the insulated wire, or its connections, will result in short-circuiting the batteries to a less or greater extent, according to the amount of leakage, and it will be equally obvious that with two insulated wires any defect in one would not produce such a result. The cost of the second wire is so small, that it is questionable if it would amount to that incurred in making the connections to the wheels or other portions of the vehicle in order to ensure a satisfactory earth return, where this course is pursued. Indeed, it is difficult to imagine why a one-wire system should ever have been preferred, unless it is to be accounted for—as is probably the case—by the fact that a two-wire connection may have presented some difficulty in the matter of coupling up the vehicles. With this branch of the subject, however, we will deal later on.

In October of last year the author, with a view to obtain data on the action of battery cells joined in groups in parallel, caused three sets of bichromate cells, composed of two-quart jars, and three sets of ordinary Leclanché, of No. 1 size, to be connected with bells as shown in fig. 1, the connecting wires being insulated. The working capacity of the cells was taken each day from October 18th to November 20th. The results are given in Table II., Appendix. There was apparently no depreciation. The positive element was free from crystals, and the electrolyte did not show depreciation. Consumption, of course, there was, but it was exceedingly small. This tallies with the experience of Mr. Houghton, who tells me that the consumption of battery power on the Brighton Company's trains—which, it will be observed, are worked under this system—is very little.

The adoption of the parallel battery arrangement, uncostly in battery consumption, possesses also the great merit that it enables the vehicles to be turned about and connected up indiscriminately, independent of the position they may occupy in the train. Switches are not needed, and, manifestly, if this is so, it is a convenience as well as an economy to dispense with them. Their object, except, perhaps, with a view to economising battery power, is not apparent.

2.—Mode of Connecting Vehicles.

It has been suggested that possibly the question of coupling up the vehicles has proved influential in the adoption of the single insulated wire and earth return. With an earth return it is necessary to make provision for joining one wire only through from carriage to carriage, the opposite pole being connected to the wheels and frame of the carriage, so as to afford metallic connection with the rails. This branch of the question appears to have proved a somewhat serious stumbling block. In the Board of Trade report we find it laid down as one of the conditions to be achieved, that the electrical coupling should be combined with one of the couplings already in use—the brake, heating service, the screw coupling, or the side chains. All, except the first named, we may at once dismiss as unsuitable, or too difficult in application to merit consideration.

Fig. 6 is an illustration of the coupling employed by the South Eastern. It consists merely of a piece of wire arranged as a spiral, with a loop at either end, which passes over a hook on the end of the vehicle, and which forms the termination of the line wire.

Fig. 7 represents the coupling employed by the Brighton Company. It is formed of a spiral of wire enclosed in an India-rubber tube. The wire terminates at each end in a galvanised iron loop, which at the end which is attached to the vehicle passes over a hook forming the termination of the line wire; but the loop at the end which has to be coupled up is divided at *a*, so as to admit the loop of the corresponding part, applicable to the adjoining carriage, passing through it.

Each of these companies is, as previously indicated, gradually introducing an uninsulated return wire, the rails in dry weather not proving satisfactory. This return wire is coupled through by a bare stranded copper wire terminated with a split spring connection, *b'*, as shown in the illustration.

Fig. 8 is the coupling used by the Chatham and Dover Company, and 8A is the coupling box. The loop, A, in coupling up, is passed over the hook, B, which, under the influence of a strong spring, holds it in good contact with the projection, C.

Following the views of the Board of Trade, Mr. Hollins, the electrical engineer to the Great Eastern Railway, has succeeded in combining the electrical communication required for this purpose with the brake coupling. The electrical parts of the coupling are countersunk in the metal portion of the brake coupling, which is cut away for their reception. The wires are arranged inside the brake tube, being connected, at the coupling end, to the electrical connections, and carried through the tubing at the end which connects with the vehicle as shown in the illustration.

Mr. Hollins has applied his electrical contact to both the Westinghouse and vacuum brake. The illustrations figs. 9, 9A, and 9B, refer to the latter, which is perhaps the more simple of the two, although I believe it is Mr. Hollins's opinion that the Westinghouse forms the better contact.

Fig. 9A shows the contact-making arrangement, which is screwed into the metal portion of the coupling as seen in fig. 9B. A is a ring of insulating material, to which metal flange and tube, B B, is secured. This tube serves to hold within it the contact-making piece, C, which is formed of a metal tube, reduced, as shown by the dotted lines at E, in order to receive a spiral spring, F, the duty of which is to press forward C, so as to ensure good contact with the corresponding part of the coupling around the edge of the tube, D, which is milled to assist in making good contact. G is a metal collar which limits the action of the spiral spring in that direction.

In 1885 the author was granted letters patent for combining an electrical with the vacuum brake coupling; but in this instance the electrical portion was superimposed upon the brake tube and coupling. It was not, however, allowed to remain long in use, serious objection being raised by that department of the service responsible for the satisfactory operation of the brake. It is believed these are the only practical attempts made with a view to effecting this combination.

FIG. 8.

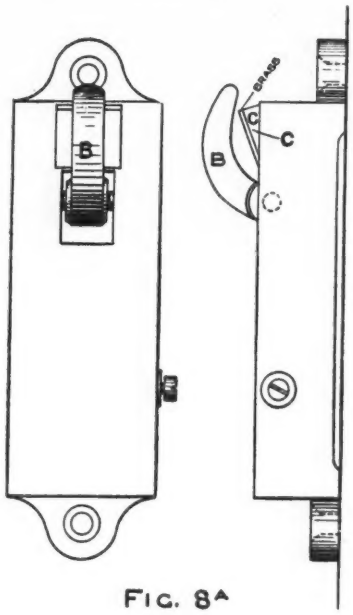


FIG. 8A

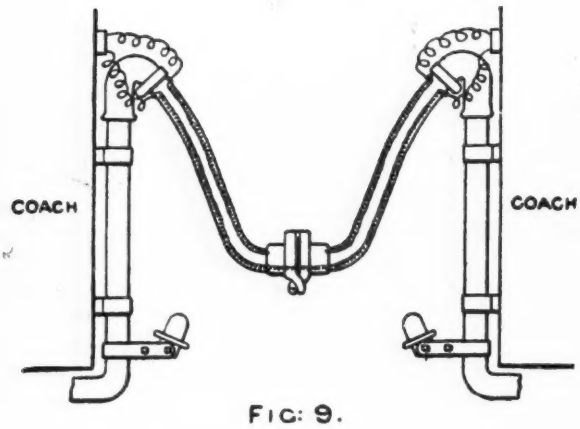


FIG. 9.

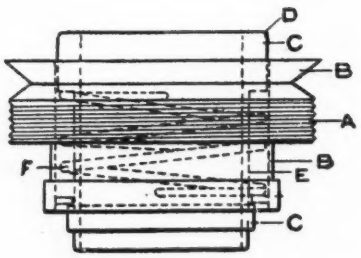


FIG. 9A

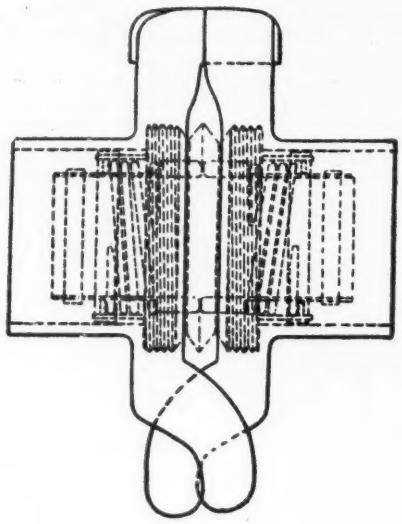


FIG. 9B

(*To be continued.*)

"Improvements in Magnetic Space Telegraphy." By Dr. Oliver Lodge, F.R.S., Member. (Paper read December 8th, 1898).

Part I. (First Portion).

The general principles of electric space telegraphy—or wireless telegraphy, as it seems to wish to be called—are fairly old; and without going into the history of the subject, with which I need not trouble you, since it has been admirably summarised by Prof. Silvanus Thompson in his lecture to the Society of Arts, I may recapitulate the three chief methods that have been tried.

First and oldest the earth current or leakage method, wherein a powerful current conveyed to the earth or sea by two well-separated electrodes causes a slight difference in potential between two other well-separated tapping electrodes at a distance, and thereby produced a feeble current through a joining wire, which can be detected telephonically or galvanometrically, or in any other convenient and known way. I am under the impression that this utilisation of earth conduction for the purpose of conveying messages has played a greater part in the past, and is perhaps destined to play a greater part in the future, than most people suspect. When, for instance, as in Mr. Langdon Davies's experience, phonoporic currents have been heard in very distant telephone trunk lines, it is difficult to be sure how much of the effect is due to a true induction from wire to wire, and how much of it is due to conduction—not only conduction through the soil from earth-plate to earth-plate, but conduction also through metals, whether gas pipes or overhead wires or other conductors arranged for other purposes. Whenever an open circuit is employed, with earthed terminals, conduction is liable to assist induction; and this may very likely be regarded as an advantage. It may also be to some extent a disadvantage, owing to its resulting in the mixing of messages; it may, in fact, contribute to ordinary telephonic cross-talk.

The second method that has been tried for purposive space telegraphy is the method by magnetic induction between two insulated line wires stretched parallel to one another along opposite coasts. This method, as is well known, has been tried under the auspices of the British Post Office, and is known as Mr. Preece's method. It is, I think I am right in saying, the only system in actual regular work; for near Cardiff, between Lavernock Fort and the neighbouring fort on the island of Flat Holm, I have myself seen it at work, and have admired the ingenious system of "call" devised by Mr. Evershed, and there employed. I desire to say that when I gave a short preliminary note to the British Association at Bristol this year, on a "call" that I had invented, I was unaware of Mr. Evershed's work in the same direction. He has undoubtedly achieved the result there aimed at, though with the expenditure of a good deal of power, and had I known, I should certainly have referred to it in my communication at Bristol. But after the Bristol meeting Mr. Preece gave me permission to visit Lavernock, and I went in company with Mr. Partridge, the telegraphic superintendent at Cardiff, to whom also I am obliged.

In the third system of space telegraphy—that by Hertz waves—

the public owes its knowledge, and interest also, to Mr. Preece, for had Mr. Preece not taken up the subject, very few persons would, in all probability, have heard of Hertz waves and Branly detectors and coherers to this day. As it is, owing to Mr. Preece's great influence and power of lecturing, this third and most recent method has become the best known of all, and, indeed, Italy is generally credited with the whole discovery. I do not intend to refer to this interesting method again to-night, but before leaving it, it may conduce to clearness if I explain wherein the Hertz wave method—at which I have also worked, in conjunction with Dr. Alexander Muirhead—differs from the older magnetic inductive method of Mr. Preece, Willoughby Smith, and others.

Every alternation in a suitable medium produces waves in one sense, but the intensity of those waves is immensely dependent on the rapidity of the alternation. A rapid pulsation of air, in and out of a hollow vessel like a resonator, may cause an extremely loud sound; a slow pulsation, of the same, or even of much greater amplitude, would cause no perceptible effect, beyond an alternate rise and fall of a sensitive barometer.

Again, a reed vibrating slightly, but quickly, is audible at a distance, while a fan vibrating strongly but slowly is not audible at all. The waves emitted by the one are strong, by the other are exceedingly weak. A magnetic alternation of sufficient rapidity induces an alternating electrostatic field, and is therefore accompanied with emission of energy. A slow magnetic alternation is practically unaccompanied by any electrostatic effects, and so practically all the energy emitted at each pulsation returns again to the source. For a progressive wave must necessarily have half its energy static and half of it kinetic energy, whereas in ordinary current-induction all the energy is kinetic.

Interrupting the explanation for a moment to touch on a practical point: It might seem, from what we have so far said, as if all the advantages lay with the rapid vibration or wave method. But when really large distances are contemplated, or when obstacles intervene, its advantages diminish and ultimately disappear; for slow magnetic pulsations are independent of all obstacles, except actual iron, if they are slow enough, and are only slightly weakened by conductors, whereas rapid pulsations or true waves are stopped by conductors and are greatly affected by obstacles. It is probable, as I have hinted above, that earth-conduction plays a considerable part in some of the coherer signalling which is supposed to occur by means of waves in space; and in all cases it is a possibility to be constantly borne in mind. The coherer is a detector of electric jerks transmitted by the earth or by uninsulated conductors such as gas pipes, and the response of a coherer is no conclusive demonstration of the receipt of actual Hertz waves.

To detect the radiation of energy, something capable of responding to waves, such as an ear, an eye, or a coherer, is appropriate; to detect the fluctuations of pressure or of magnetic field, something akin to a barometer or magnetometer would seem to be appropriate; but, inasmuch as these instruments only indicate the state of things at their immediate locality, another device can be employed which shall integrate the effect over a considerable area and therefore be much more sensitive. Such a device is afforded in the case of magnetism by Faraday's current-induction. A circuit connected with any electric detector, such as a telephone, may surround a large area and give an induced current depending on the variation in the total lines of force passing through the entire area.

In the Lavernock signals, considering them as due to wire induction, the inducing and induced areas are both long narrow strips in a vertical plane, with their long sides horizontal and their faces parallel; each being constituted by the space between a long overhead line on posts and the return earth—or, rather, sea—circuit.

But in some interesting experiments made by Mr. Stevenson near Edinburgh he employed a horizontal coil of wire approximately circular—in one case utilising some farm fencing, I believe—and by means of a battery and key at one station was able to hear Morse signals in a telephone in another like coil half a mile away. This certainly resulted from pure induction, and it may be considered to represent the closest approach hitherto made to the method I have to bring forward to-night.

Unfortunately, Mr. Stevenson made a slight error in the theory, and perhaps for that reason did not continue the attempt over larger distances. He says that with a given number of ampere-turns the hearing distance increases with the square root of the diameter of one of the coils, or with the simple diameter of both coils, thus making it necessary to double the size, quadruple the area, of each coil if the distance is to be doubled; and, since he used 1,600 yards of wire in each coil to signal half a mile, he may have considered the cost prohibitive for any really great distances, as, indeed, it is, with mere unaided coil induction.

But, in truth, the law of distance is not the square root of the diameter, but the two-thirds power, *with a given primary current*; and so doubling the circumference of each coil will enable signalling over more than double the distance, if other things can be kept the same.

It is true, however, that for such magnification the thickness of the wire must be magnified likewise, or else more power will be consumed in the enlarged coil; and this consideration, together with others shortly to be stated, does speedily make the cost prohibitive, unless some fresh revolutionary devices are employed.

The devices I have to lay before you to-night contain nothing new in principle—*i.e.*, they involve no discovery—but, inasmuch as they make practical over big distances what has been actually successful over small distances, I venture to attach some importance to them, and think them worthy of your attention.

First I have to explain my system of magnetic induction telegraphy, and next the extra sensitive receiving instrument which may be employed with it.

The chief feature of my magnetic system is the outcome of an electric resonance experiment which I described eight years ago (see *Nature*, Vol. xli., page 368), viz., the experiment of the syntonic Leyden jars. The term "resonance" is generally and properly understood as having an acoustic significance, and where no reference to sound is intended, I advocate the use of the more general term "syntony" to denote the sympathetic response between two vibrators attuned to the same "note," or more generally to the same frequency of vibration, whether that vibrator be mechanical or electric or magnetic.

Two similar Leyden jars connected to similar circuits are, or may be, thus syntonised, and any electric oscillation in one causes a feebler electric oscillation in the other; the medium of communication in this case being the alternating magnetic field between the two circuits, the lines of force of the one circuit penetrate the other, and by their fluctuation cause an alternating electromotive force of feeble intensity. In a distant circuit *not* containing a Leyden jar, and therefore not susceptible of any tuning, because it has no natural frequency of vibration, nothing can be perceived; but when a Leyden jar exists in a circuit, that circuit has at once a natural frequency of vibration which may be syntonised with that of the emitting circuit, and in that case the intensity of the reverberating induced electromotive force may rise as high as several thousand volts, and cause a spark over a very perceptible air gap.

Now, for telegraphic purposes, I replace the Leydon jar by a condenser of considerable capacity, and the circuit of the jar becomes a large horizontal coil of wire—it may be of one turn, or it may be of more; and the frequency of vibration, instead of being the million or so per second appropriate to Leyden jars, becomes the thousand or even hundred per second appropriate to sound. Hence, instead of using a spark gap to detect the disturbance, I use either a coherer or else a telephone as a shunt to the receiving condenser. Further, although the momentary oscillation of a spark constitutes a possible sender, I generally employ some form of alternating or intermitting machine of considerable power as the sending appliance, and carve its fluctuating current into long and short spells, as everyone else working at the subject has done.*

I have at my house a cable a quarter of a mile long altogether, enclosing an elongated rectangle, say, 150 × 30 square yards, and with that I can hear all that goes on in the neighbouring telephone wires, and can even answer back with a suitable microphonic transmitter; but, there being, I suppose, no phonopore in the neighbourhood, I hear no stray musical note; the only musical note I hear is the one belonging to the desired signals when they are being sent to me from an equal length of cable round an equal but squarer contour at the College about two miles away, or 2·5 kilometres in a direct line.

I may say that, although the Leyden jar or condenser constitutes a leading feature of my system, I have occasionally, as an experiment, dispensed with it, and tried what could be done with the area-enclosing circuits alone. But under those conditions, with the power I had at my disposal, I was not usually able to hear anything. I was using a small low-frequency dynamo of the Pyke & Harris pattern, and at the sending end had a current of 10 or 12 amperes going round the circuit, sometimes as much as 25 amperes. Under these circumstances, on the ordinary National Telephone Company's telephones the sound could be heard many miles away; away over in Cheshire, towards the Dee, the signals could be clearly heard, while close to the college, the subscribers, unfortunately, became rampant; but through empty space the signals only became audible at a distance of two miles when a condenser was used and the circuit properly attuned. I am speaking now of the early trials, when no suitable receiving telephone was employed, but only the first to hand. The cable, bought for the purpose of the trial, was described as anti-inductive telephone cable (not exactly the variety required), and it was very badly insulated, having been bought as little more than old materials; but still it might, perhaps, have been expected to do better. Directly the circuits were syntonised, however, there was no difficulty in hearing the note and the signals. I should say that I did not work with the fundamental frequency of the dynamo—128 per second, or thereabouts—but with the third harmonic, which is fairly strong in these Pyke & Harris alternators, of frequency 384. Such a note is pleasanter to listen to than a deep bass, the ear is far more sensitive to it; and, moreover, to attune the circuit to the lower frequency would have entailed a prodigious capacity. As it was, I used 28 microfarads, and had to insert the thick wire of a hedgehog transformer in the circuit too, in order to get the induced circuit frequency as low as 384, with the quarter-mile length of cable once round.

I generally used a couple of Ader telephones in series, each of about 70 ohms resistance, and connected them thus as a shunt to the receiving condenser.

The resistance of the receiving cable itself was only 0·07 ohm (it consisted of 100 No. 18 wires all in parallel), so that if the telephone had been in series with it, a very low resistance winding would have to be employed, and in the early trials I did not happen to have such a telephone handy. I did, however, use a Western Electric loud speaking telephone of 2 ohms resistance occasionally. A transformer, of course, was sometimes used, but it wastes power. Besides, the low resistance of a transformer winding is apt to be rather illusory when its higher resistance secondary is closed.

At the sending end also condensers were employed, in series with dynamo and coil, in order to strengthen by resonance the third harmonic at the expense of the fundamental. The cable there was about 400 yards of well-insulated telephone cable, consisting

* In the original paper a detailed quotation concerning Mr. Stevenson's experiment was here made, under the belief that signalling to a lighthouse at the Shetlands had been tried; but this was a mistake. The experiment was only a preliminary one near Edinburgh, and does not appear to have satisfied the Post Office officials who helped to conduct it.

virtually of 20 strands of separately insulated No. 16 wire, slung on poles round a squarish contour; but, unfortunately, it was again sheathed in lead so as to be nominally "anti-inductive."

I found it best usually to join these 20 wires in five series of four strands each; and the current in each strand being then, say, 6 amperes, I call the whole current in the cable 24 amperes.

The receiving cable I could also at first employ in separate strands, for its 100 wires were supposed to be insulated with thin India-rubber. The first time I heard the note I had 19 of these strands in series without a condenser, constituting a coil of 19 turns, connected to an Ader telephone. Since then, however, the insulation has so much broken down that I am constrained to use all the wires in parallel, which for many purposes is not so convenient.

Advantage of Syntony.

Now proceed to consider more particularly the elementary theory of magnetic induction telegraphy between two large distant horizontal coils, first without, then with condensers; taking the case, however, of an alternating current, and not the simple make-and-break battery arrangement employed by Mr. Stevenson, which obeys somewhat different laws.

The first proposition I wish to maintain is that no unaided simple induction process can work satisfactorily over really big distances unless an altogether prohibitive amount of wire or an extravagant amount of power is employed.

This proposition I prove by considering the strength of current induced in the distant circuit. Let a and b be the radii of the two coils, considered circular, n and m their turns of wire, and r their distance apart from centre to centre, this last being considerable: then the mutual induction coefficient—*i.e.*, the total lines of force passing through one coil due to unit current in the other—is

$$\text{M} = \frac{n \pi a^2 m \pi b^2}{r^3}.$$

The resistance is

$$\frac{2 n \pi a}{\pi c^2} \rho \text{ for one, and } \frac{2 m b}{d^2} \rho \text{ for the other.}$$

The self-induction is

$$4 \pi \mu n^2 a \left(\log \frac{8 a}{c} - 2 \right);$$

or, for present approximation—accurate if one coil is like the other magnified—*i.e.*, if they are really "similar coils"—the self-inductions are

$$k n^2 a \text{ and } k m^2 b.$$

Now, if E is the electromotive amplitude maintained in the primary, the current-amplitude induced in the secondary is

$$x = \frac{p \text{ M E}}{\text{J}_1 \text{J}_2},$$

where J_1 and J_2 are the impedances.

For rapid alternations and good stout wire the value of J is not much bigger than p L; hence the most favourable case for the mere pair of circuits without condensers gives

$$\frac{x}{\text{E}} = \frac{\text{M}}{p \text{ L}_1 \text{L}_2} = \frac{n m \pi^2 a^2 b^2}{p n^2 m^2 k^2 a b r^3},$$

which is, therefore, the "virtual conductance" of the whole system.

The first and most important thing we observe here is that p occurs in the denominator, so that high frequency is actually disadvantageous—other things being equal, which they usually are not, because high tones are best to listen to.

The next thing to notice is that number of turns of wire occurs in the denominator, so that a single contour is much better than a coil of many turns; except in so far as many turns help to emphasise self-induction at the expense of resistance, and so to bring about the above "most favourable" conditions where resistance can be neglected.

Lastly, we observe that the linear dimensions of each coil occurs only once in the numerator, and that their product is therefore incompetent to cancel the cube of the distance in the denominator, when both wire and distance are magnified in the same proportion, and when both are big. Observe, we are not here taking the case of a *given current* in the primary, but the more practical case of a given E.M.F.

Moreover, we see that extra thickness of wire gives no advantage: if the wire is thin, the induced current will be less than the above; but no increase of thickness can make it greater than the value of x now calculated, viz.:

$$x = \frac{\pi^2 a b \text{ E}}{k^2 p m n r^3}.$$

Hence I say that no simple induction system can work over really big distances unless an altogether prohibitive amount of wire or an extravagant amount of power is employed. If for a certain distance a total length of wire, l, is just sufficient, it is best disposed in equal contours of one turn each; and the ratio between the induced secondary current and the applied primary E.M.F., without allowing anything for the impedance of the receiving telephone, is then

$$\frac{l^2}{16 k^2 p r^3}. \qquad (1)$$

To signal double the distance $2\sqrt{2}$ times the length of wire is necessary; and to signal 10 times the distance the necessary length of wire is 32-fold, its thickness being increased at the same time so as to keep resistance down.

Introduction of Condensers.—But now, directly condensers are introduced both into sending and receiving circuits, and are adjusted until each circuit is attuned to the applied frequency, the conditions are greatly altered. When the correct note is reached all self-induction is abolished, and the impedance becomes simple resistance. Hence in this case the induced current is

$$y = \frac{p \text{ M E}}{\text{B}_1 \text{B}_2},$$

or

$$\frac{y}{\text{E}} = \frac{p a b \pi^4 c^2 d^2}{4 \rho^2 r^3}.$$

The most important thing to notice here is that p occurs in the numerator, so that high frequency is specially advantageous. The number of turns is immaterial, instead of being objectionable as in the former case, and this fact is often convenient for tuning. And a great gain results from increasing the thickness of the wire, whenever a big distance is to be attempted.

If the whole bulk of wire employed is w, and if it be distributed equally between the two stations, in a single turn at each, the ratio between the secondary induced current and the applied primary E.M.F., again without allowing for the resistance of the receiving telephone (its "reactance" has been already neutralised if it is connected in series), is in this case

$$\frac{p \text{ w}^2}{64 \rho^2 r^3}. \qquad (2)$$

Comparing this with (1), the chief difference consists in the position of p; but this is a tremendous difference—representing something like a million-fold factor.

To take a numerical example in illustration of the two cases. Let the applied E.M.F. be 100 volts, the frequency 400 per second, the total length of wire, say, 2 kilometres, and its thickness 2 centimetres (about 5 tons of copper altogether): then

$$k = 125 \text{ about, } p = 2{,}500, \text{ and } \rho = 1{,}600 \text{ sq. cm. per second.}$$

So at a distance of 100 kilometres the maximum received current possible is, by simple conduction without condensers,

$$x = \frac{4 \times 10^{10} \times 10^{10}}{16 \times (125)^2 \times 2{,}500 \times 10^{21}} \text{ C.G.S. units,}$$

or 0·0064 *micro*ampere; which is quite insufficient to affect a telepone. That is the result in the first case; whereas, in the second case, with condensers and the circuit properly attuned the current might be

$$y = \frac{2{,}500 \times (6 \times 10^5)^2 \times 10^{10}}{64 \times (1{,}600)^2 \times 10^{21}} \text{ C.G.S.}$$

or 0·5 *milli*ampere, which is quite a strong telephonic current.

Induction *v.* Conduction.

As to the question between space induction and earth conduction, and the relative part each plays in any given case, it is a question which can be answered either by experiment or by calculation. In some cases experiment would be absurd, as, for instance, when either sending or receiving circuit is not earthed anywhere; in other cases, as at Lavernock, it can be answered either way. Now Mr. Gavey tells me that he has tried an experiment on this very point, by taking an insulated wire outstretched between two boats and "earthed" in the sea at either end. Signals being sent from the land, they could be heard out at sea to a certain distance when the wire was above water, but when it was immersed they disappeared at a smaller distance. The argument, of course, is that, regarded as the tapping electrodes of a conductive receiver, the ends of the wire acted similarly both times; but regarded as an inductive receiver responding to magnetic influences, the submerged wire was protected, because, let us say, the direct and return portions of the circuit, when the wire was immersed in the sea, were more or less coincident. And the moral is that induction contributed the greater part of the effect. It is not quite conclusive, however, because induction and conduction may aid each other anyhow, and, when either is stopped, the residual disturbance may be too faint to hear. A trial with a continuous current might, I think, conclusively measure the part due to conduction. So far as I know, no attempt has been made to dispense with earth conduction altogether, by the use of a return wire along the beach; but calculation shows sufficiently that if this were done signalling would practically cease. It is a mistake to suppose that the negative result with the submerged wire depends on the reflection of electro-magnetic waves at the surface of water, because true electro-magnetic waves have in this installation nothing to do with the case. The water may and does to some extent act as a conducting screen, but it is sufficient to consider the immersion of the wire as resulting in simply closing up the receiving circuit until it is a long thin rectangle of inappreciable area, so that the direct and return circuits almost coincide. The experiment proves distinctly that induction has something to do with the result, and that it is not only due to earth tapping. Let us see if calculation bears this out.

Without presuming to quote exact details of an installation on which I am not authorised to report, I state only the facts obvious to inspection of the stations by boat.

The distance between the earth-plates, or length of the base line, I take to be: At Lavernock, 1 mile; at Flat Holm, ½-mile.

The average elevation of the line wire I take as 120 feet above the sea in each case; the elevated lengths as 1,200 and 460 yards respectively; and the distance between the stations as 3½ miles.

It may be noticed that in any case, even in this case where the line is straight, the bulk of the impedance is of the "reactance" kind,

when a thick wire and high frequency are employed.* For, whereas the resistance might be something between 1 and 2 ohms, the value of $p\,L$ is something more like 10 ohms if a note of 400 per second is employed; and in such a case the induced current is almost independent of the frequency, because $\frac{p\,M\,C}{p\,L}$ = constant as regards frequency.

Hence, with a stronger primary current and lower frequency—say, 20 amperes alternating 20 times a second—the effect received would be decidedly stronger; whereas, if *resistance* had been the dominant feature, the effect of the stronger slower current would have been just the same as that of the smaller quicker one. It is chiefly for response at low frequency, I take it, that such thick copper wires have had to be employed; for, at low frequency, resistance does become the dominant feature.

Now, treating the sea first as if it were a superficial return circuit, or, rather, treating the case of a return wire along the beach, vertically below the line wire, the mutual induction coefficient between two facing circuits of areas 40 × 1,200 square yards and 40 × 460 square yards respectively, at a distance of 3½ miles, is

$$M = \frac{2 \times 4{,}800 \times 18{,}400}{(6{,}160)^3} \text{ yards},$$

or, say, 0·008 yard, or 0·73 centimetre.

Accordingly, when a current of frequency 400 and 1 ampere mean strength is sent round either circuit, an E.M.F. is induced in the other of average value,

250 M C.G.S., or 1·8 micro-volts.

And I doubt if this could produce any appreciable effect; unless, indeed, the whole of the receiving circuit were attuned and arranged in the way to be presently described.

But a return circuit along the beach is not employed, and would evidently be very ineffective if it were. A return by the sea gives a more open area, and therefore an inductive advantage, in addition to any conductive contribution which it may furnish.

The other extreme case, decidedly more unfair in the opposite direction—so extreme that it is hardly worth consideration except as a warning not to reckon the mutual induction in this way—would be to treat the line wires as if isolated in space—bits of infinite parallel wires—the return current being at infinity. Taking this case for a moment, the mutual induction would be

$$M = \frac{1{,}200 \times 460}{6{,}120} \text{ yards},$$

or about 80 metres, which must be far beyond the truth.

The actual return circuit depends on the distribution of conductivity in the earth, and is, therefore, indefinite. The fact that the resistance of the circuit varies with the height of the tide shows that the *sea* conveys most of the current.

Earth Conduction.

Now, calculating what share earth conduction ought to contribute in the matter, we may either treat the shallow sea as a conducting sheet fairly insulated in its bed, or we may postulate equal conductivity through the whole earth; the latter being certainly further from the truth than the former.

Considering the electrodes as approximating in area to spheres of radius c, at a distance $2\,a$ apart, the applied difference of potential between them is

$$V = \frac{Q}{\pi\,k\,\delta} \log \frac{2\,a}{c};\dagger$$

k being the conductivity, and δ the depth of the sea, supposed uniform and small, and Q being the quantity of electricity supplied per second.

The potential at any point distance r from one electrode and r' from the other is

$$U = \frac{Q}{2\,\pi\,k\,\delta} \log \frac{r'}{r};$$

so between two fairly neighbouring points situated symmetrically on either side of a point at a considerable distance r from either electrode,

$$d\,U = \frac{Q}{\pi\,k\,\delta} \cdot \frac{d\,r}{r}.$$

The distance between these tapping points being $2\,b$, we have

$$\frac{d\,r}{b} = \frac{a}{r};$$

therefore the ratio of the tapped voltage to the total applied voltage is

$$\frac{d\,U}{V} = \frac{\frac{a\,b}{r^2}}{\log \frac{2\,a}{c}}.$$

Now, taking c as a metre, $2\,a$ as a mile, $2\,b$ as ½-mile, and r as 3½ miles, we find that the tapped E.M.F. is a certain fraction of the difference of potential on the primary electrodes; the fraction being,

$$\frac{1}{3 \times 3\frac{1}{2})^2} = \frac{1}{\text{log. } 1{,}500} = \frac{1}{37 \times 2\cdot3 \times 3\cdot18} = \frac{1}{270};$$

which represents a very considerable voltage. But this is the most favourable case, with the current limited to a sheet of sea only a few metres thick. An uncertain amount of current would be certainly lost by real earth conduction, and the other extreme case would be to take the whole earth as of uniform conductivity with sea water. This would give us very much too low a result, as the hypothesis of sea conduction alone has given us one too high. Considering the whole earth as conveying the current, half the tapped E.M.F. is

$$U = A\left(\frac{1}{r} - \frac{1}{r'}\right) = A\,\frac{d\,r}{r^2} = A\,\frac{a\,b}{r^3},$$

while the applied E.M.F. is

$$V = 2\,A\left(\frac{1}{c} - \frac{1}{2\,a}\right) = \frac{2\,A}{c} \text{ approximately};$$

so the fraction $\frac{d\,U}{V}$ in this case is $\frac{a\,b\,c}{r^3}$, a fraction so small as to give an imperceptible result

(To be continued.)

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* I emphasise this because it has been doubted by the Post Office. A method for calculating the self-induction of a straight wire of length l and sectional radius c is given by Lodge and Howard in the *Phil. Mag.*, July, 1889, page 64, and results in $L = 2\,l \log \left(\frac{4\,l}{c} - \frac{3}{4}\right)$. Apply this to the Lavernock line wire: say, l = 1 mile, c = ½-inch, we get L = 4 milli-henries; so for a note of 400 per second $p\,L$ = 10 ohms; and this is the practical impedance of the straight wire—its resistance being much smaller. It is a great mistake to suppose that in straight wires the self-induction is negligible.

† See, for instance, Foster and Lodge, *Phil. Mag.*, June, 1875, p. 453.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1898.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

26,191. "Improvements in electric switchboards." E. W. Cowan and A. Still. Dated December 12th.

26,210. "Improvements in dynamos and electric motors." F. O. Prince. Dated December 12th.

26,214. "Improved electrical furnace." E. B. Phillips and W. H. Bray. Dated December 12th.

26,239. "Improvement in electric measuring instruments for three-phase systems." J. Wetter. (The Elektrizatäts Aktiengesellschaft vormals Schuckert & Co., Germany.) Dated December 12th.

26,248. "Improvements in or relating to starting switches for electromotors or the like." J. W. Gibbs. Dated December 12th.

26,251. "Improvements in the construction of electrical transformers with ventilating passages." O. T. Blathy. Dated December 12th. (*Complete.*)

26,257. "An improved method of and apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines." L. De Coincy. Dated December 12th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 6th, 1898, being date of application in France.)

26,285. "Improvements in switches for electrically worked lifts, hoists, and the like." S. H. Heywood and H. W. Heywood. Dated December 13th.

26,310. "Improvements in junction boxes, switches, wall plugs, and distribution boards for use in electric wiring." G. A. Clark, W. McAulay, and J. A. McLaren. Dated December 13th.

26,322. "Improvements in and relating to apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines." L. De Coincy. Dated December 13th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, October 7th, 1898, being date of application in France.)

26,323. "Improvements in the frigorific electro-spray." E. S. D'Oriardi. Dated December 13th.

26,325. "Improvements in electrodes of deep penetration." E. S. D'Oriardi. Dated December 13th.

26,326. "Improvements in abscess bells and electrolysers." E. S. D'Oriardi. Dated December 13th.

26,327. "Improvements in electro inhalers and nascent ozone producers." E. S. D'Oriardi. Dated December 13th.

26,328. "Improvements in electro vaporisers and ozonisers." E. S. D'Oriardi. Dated December 13th.

26,334. "Improvements in electric switches." W. J. Ferguson and W. G. H. Stump. Dated December 13th.

26,335. "Improvements in telegraphic receiving and translating instruments." A. Muirhead. December 13th.

26,343. "Improvements in the manufacture and production of plates or elements for secondary batteries or electrical accumulators." C. Brault. Dated December 13th.

26,351. "Improvements in galvanic elements or batteries." J. Wetter. (M. Maas, United States.) (*Complete.*)

26,380. "Improvements in electric batteries." E. Giglio. Dated December 13th.

26,381. "Improvements in conduits for electric conductors." J. J. Bate. Dated December 13th.

26,397. "An improved acid-proof or non-conducting material for electrical and other purposes and method of preparing the same." C. Jung, A. Brecher, and A. Kittel. Dated December 13th. (*Complete.*)

26,401. "Improvements in bath apparatus for treatment with electricity and medicinal substances." C. E. Schnee. Dated December 13th. (*Complete.*)

26,412. "An improved terminal for electrical fittings and apparatus." J. Stoddart. Dated December 14th.

26,419. "Improvements in and relating to dynamo-electric motors." H. Humphreys and W. Humphreys. Dated December 14th.

26,420. "Improvements in fusible cut-outs." C. M. Dorman and R. A. Smith. Dated December 14th. (*Complete.*)

26,422. "An improved electrical governor for steam engines and the like." W. Shinn. Dated December 14th.

26,458. "Improvements in collectors for electric tramways on the overhead conductor system." R. Rainsford. (John Walsh, United States.) Dated December 14th.

26,476. "Improvements in batteries." C. E. Burroughs. Dated December 14th. (*Complete.*)

26,479. "Improvements in electricity meters." G. Hookham. Dated December 14th.

26,494. "Improvements in electrical switches." A. Watson. Dated December 15th.

26,526. "A new or improved crucible for casting lead or like metals under pressure, especially applicable to the formation of secondary electric battery grids or plates." E. J. Clark. Dated December 15th.

26,527. "Improvements in regulators for electric car motors." H. H. Lake. (H. S. Maxim, United States.) Dated December 15th.

26,559. "Improvements in and connected with phonographs and like apparatus." S. Rosenthal. Dated December 15th.

26,566. "Improvements in telephone transmitters." F. H. W. Higgins. Dated December 15th.

26,604. "Improvements in telephonic or other switchboard apparatus." F. W. Francis. Dated December 16th.

26,610. "Improvements in electric arc lamps." R. E. B. Crompton and E. A. N. Pochin. Dated December 16th.

26,614. "Process and apparatus for treating ores by electrolysis." J. A. Mays. Dated December 16th.

26,619. "Improvements in telephone switchboards, or switching apparatus for telephone stations." W. P. Thompson. (T. F. Ahern, United States.) Dated December 16th. (*Complete.*)

26,621. "An improved phonograph." E. Parisse. Dated December 16th. (Date applied for under Patents, &c., Act, 1883, Section 103, May 27th, 1898, being date of application in France.) (*Complete.*)

26,629. "Improvements in current collectors." E. Penning-Dubois. Dated December 16th. (*Complete.*)

26,649. "Apparatus for simultaneously actuating from one point the controlling switches of the several electrical motor cars of a train." Siemens Bros. & Co., Limited. (Siemens & Halske, Aktien Gesellschaft, Germany.) Dated December 16th. (*Complete.*)

26,650. "Improvements in or relating to electric lamps." Andeas. Dated December 16th.

26,695. "Improvements in electric accumulators or secondary batteries." W. Puttkammer. Dated December 17th.

26,700. "Improvements relating to the coating of metals with metals by the aid of electricity, and to apparatus therefor." F. H. Snyder. Dated December 17th.

26,703. "Improvements in primary batteries." H. T. Harrison. Dated December 17th.

26,706. "Improvements in cable lightning conductors." J. Boens. Dated December 17th.

26,723. "New or improved device for indicating the frequency of an electric current or currents, derivatively applicable for signalling and indicating speeds and the like." W. E. Burnard. Dated December 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free*, 9d. (*in stamps*).

1898.

6,637. "Improvements relating to the electrolytic production of metallic alloys and to apparatus therefor." C. E. Acker. Dated March 18th, 1898. This invention consists of an improved electrolytic process and apparatus for the manufacture of metallic alloys. The process consists in submitting a fused salt, *e.g.*, the chloride of sodium, to electrolysis, while superimposed upon a molten mass of the heavy metal, *e.g.*, lead constituting the cathode, and thereby forming an alloy of sodium and lead; in mechanically circulating this alloy so that the lighter and richer portion formed on the surface will be removed into and accumulate in an adjoining chamber whence it will overflow, or from which it may be periodically tapped. 7 claims.

10,269. "Improvements in alternating current motors." The British Thomson-Houston Company, Limited. Dated March 4th, 1898. Relates to improvements in the operation of alternating current induction motors, it consists in the arrangement for compensating for lagging currents within the motor itself as well as in the external circuit, so as to increase the power factor output and efficiency of the motor, as is well known in single-phase induction motors are not ordinarily self-starting, but by arranging an auxiliary closed induced circuit in which leading currents are maintained in inductive relation due to the inducing and to the auxiliary induced circuits will respect, be out of phase and will secure the two-phase effect desired for giving the motor starting torque. 21 claims.

13,012. "Improvements in caps for enclosing electric arc lamps." The British Thomson-Houston Company, Limited. Dated June 10th, 1898. The object of this invention is to provide a cap for the arc-enclosing cylinder, which will properly regulate the admission of air to the globe, at the same time withstand the heat to which it is subjected. It consists of a cap which surrounds the upper carbon of electric arc lamps, and rests on the top of the small cylinder surrounding the arc. 4 claims.

15,041. "Improvements in circuit breakers." British Thomson-Houston Company, Limited. Dated July 8th, 1898. This relates to circuit breakers for power stations or any other relation to which it is desirable to open a circuit carrying a heavy electric current. The device is so arranged that the handle moves down to set the contacts instead of moving up. This arrangement enables the circuit breaker to be set high up on the switchboard, so that when the circuit is opened the arc is above all the apparatus and not likely to do injury. The handle is so arranged that it closes the contacts by a toggle device between the handle and a swinging arm carrying the contacts, the range of motion of which diminishes as the contacts are more nearly closed, so that while the movement of the bridging contact is through the air the handle moves comparatively slowly and the contact moves rapidly; but after contact is made between the bridge and the terminals the movement of the handle is greater and that of the contact less so that an increased leverage is obtained, rendering it comparatively easy to close the contacts. 7 claims.

15,203. "Improvements in arrangements for exciting the magnets of dynamo machines." M. Deri. Dated July 11th, 1898. This invention relates to the excitation of the magnets of dynamo electric machines having armatures with commutators in such a way that the resulting field has a constant direction, even when the current of the armature, as generator or motor, varies between wide limits or the direction of rotation of the armature changes. For this purpose the field is arranged in the form of a shell or cylinder, with the iron equally distributed around and equidistant from the armature. The cross-section of iron and the air space for the flow of magnetic force are uniform over the whole circumference. 3 claims.

16,029. "Improvements in or relating to electric furnaces." G. L. Palmer, J.P., and E. Williams. Dated July 22nd, 1898. The particular object of this invention is the production of calcium carbide by a quickened process and greater economy of heat. It is applicable to electrical smelting, melting of metals, and the reduction of oxides. A high degree of temperature compared to the strength of the electric current is attained by utilising the heat generated within the furnace during one operation, for heating to a high temperature the charge which is about to be introduced into the furnace for the next operation. 4 claims.

German Electrical Engineering Firms.—The following details of the capitalisation and number of employés of the leading electrical engineering firms in Germany will be of interest to some of our readers. The information is taken from the supplement to *L'Eclairage Electrique* for October 8th, 1898:—

Siemens & Halske.—Share capital, £3,250,000; debentures, £1,500,000—total, £4,750,000.

Allgemeine Electricitäts Gesellschaft.—Share capital, £2,350,000; debentures, £1,950,000—total, £4,300,000. This company employs 8,000 workpeople, and is interested in installations in Barcelona, Buenos Ayres, Geneva, Kieff and Bilbao, in addition to many in Germany.

Société Schuckert, of Nuremberg.—Share capital, £1,850,000; debentures, £300,000—total, £2,150,000. This company employs 4,000 workpeople, and in 1897 turned out work of the value of £3,000,000.

Compagnie l'Union.—Share capital, £2,050,000; debentures, £600,000—total, £2,650,000. This company exploits the Thomson-Houston patents in Germany.

Helios Elektricitäts Gesellschaft.—Share capital, £1,200,000.

Most of the shares in the above companies are held by German banking houses, thus illustrating the points raised in our issue of October 14th. In 15 years £20,000,000 has been invested in this manner in electrical engineering and electric supply companies in Germany.

THE ELECTRICAL REVIEW

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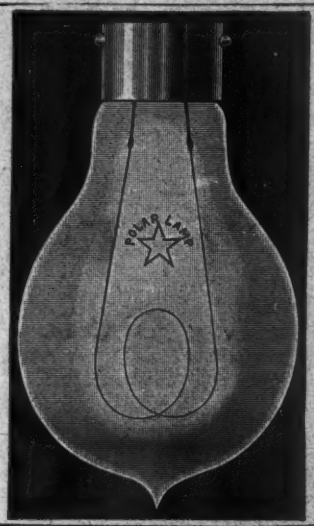

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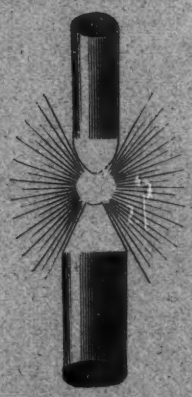

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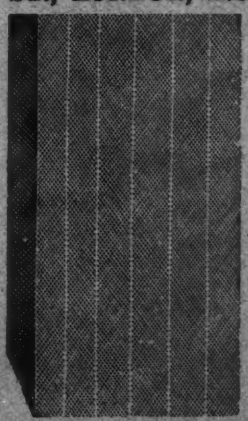

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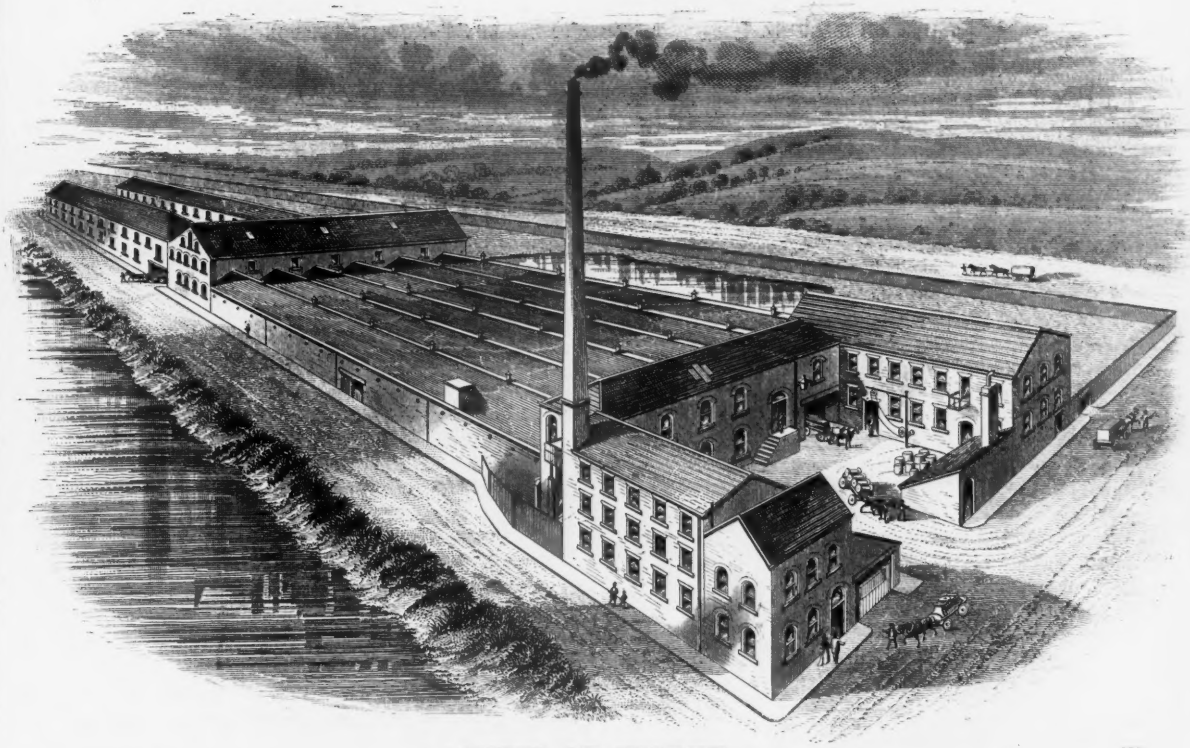

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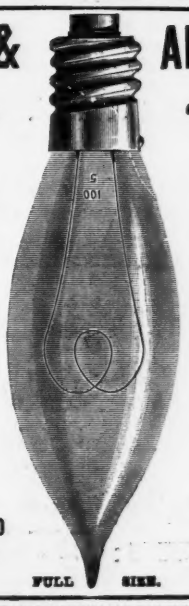

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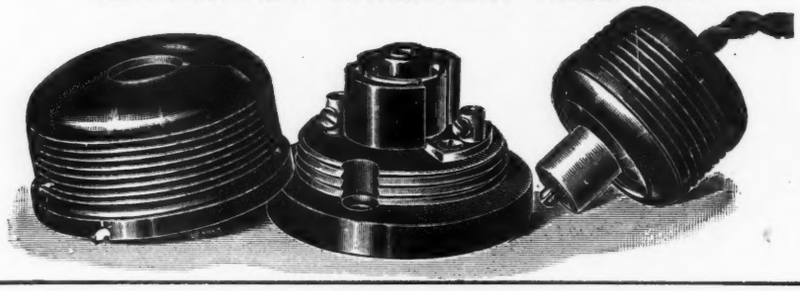

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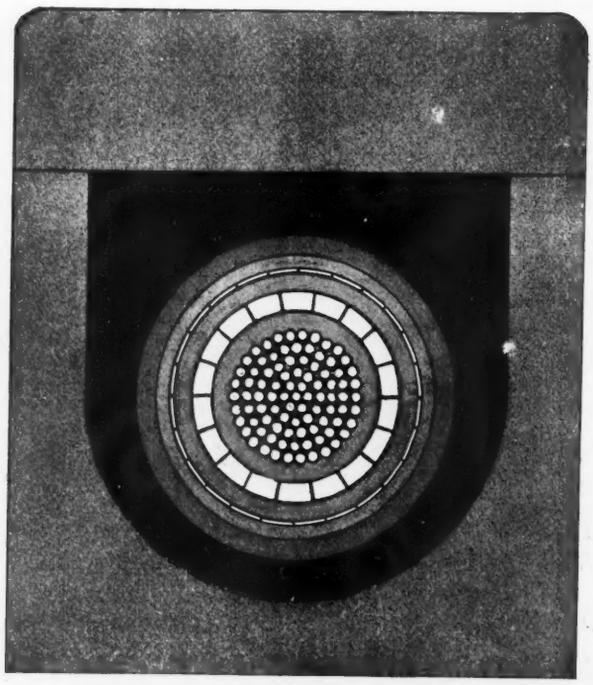

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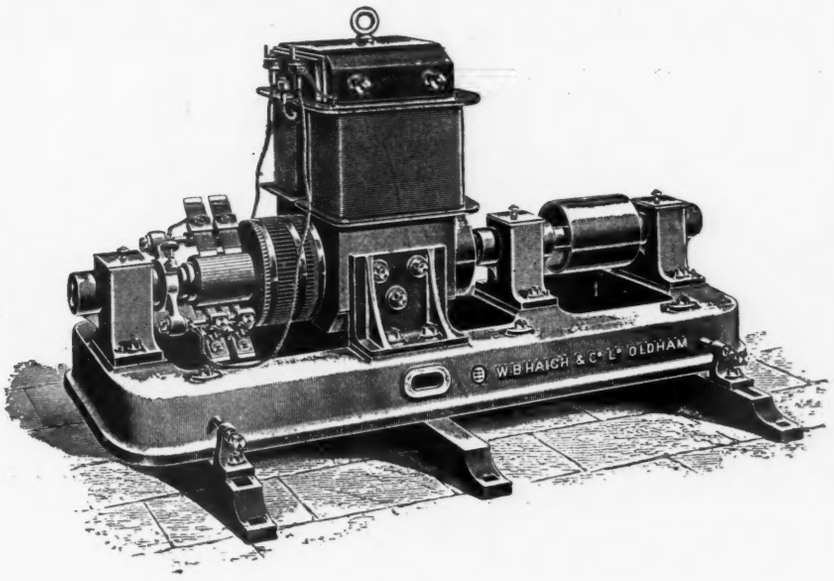

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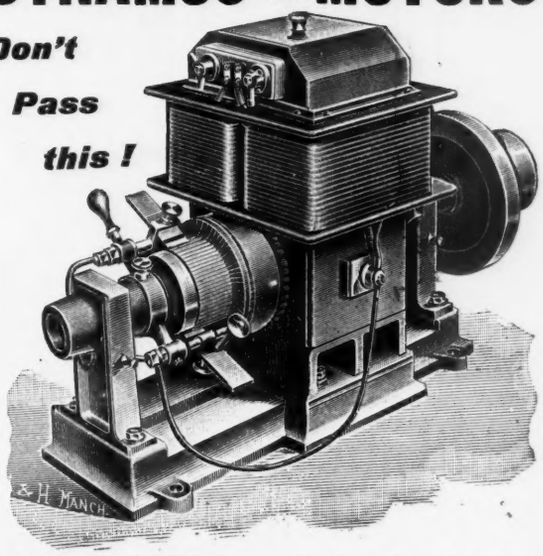

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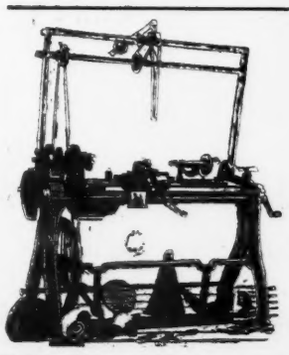

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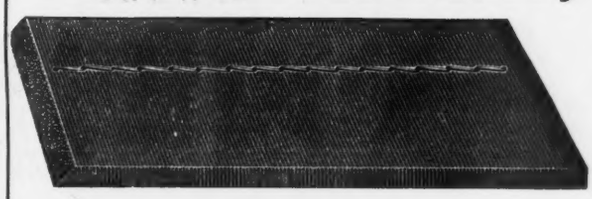

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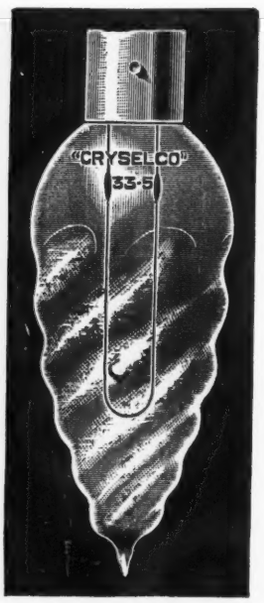

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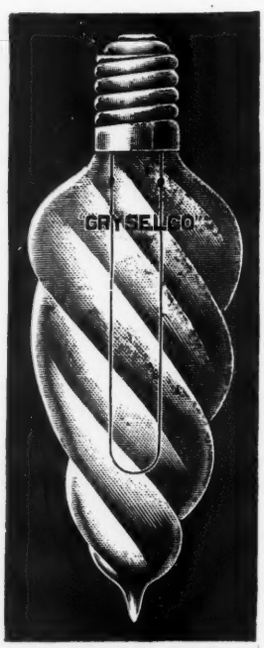

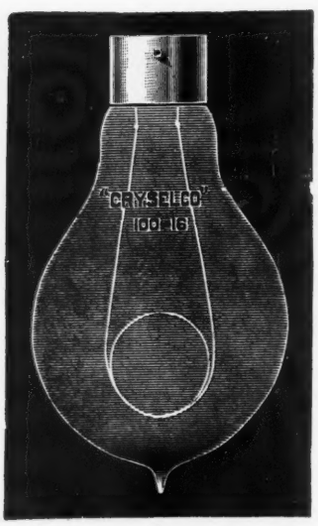

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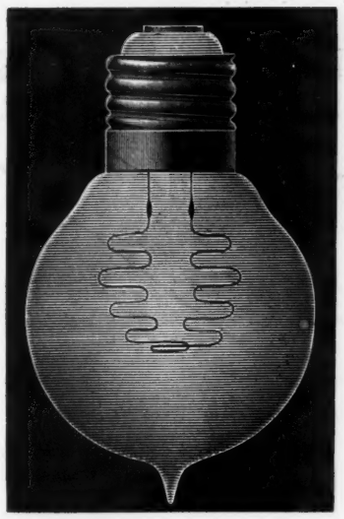

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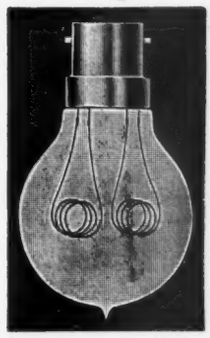

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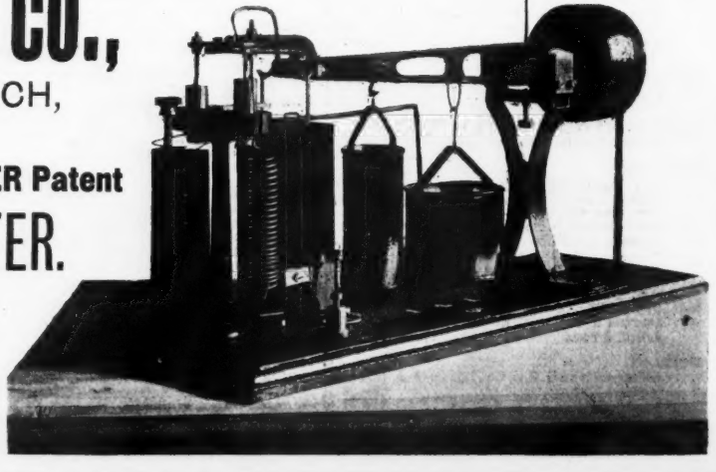

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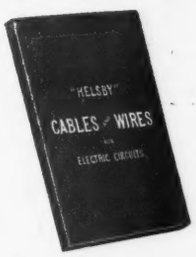

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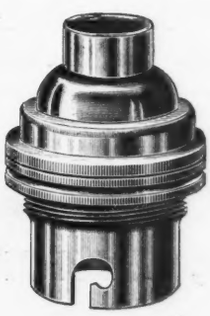
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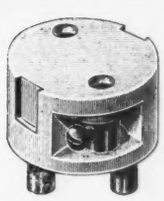
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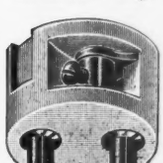
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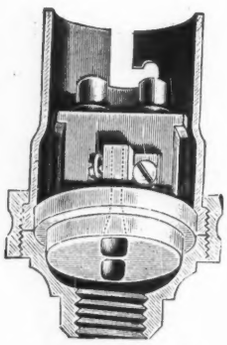

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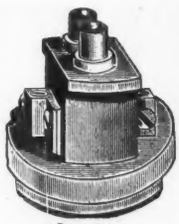

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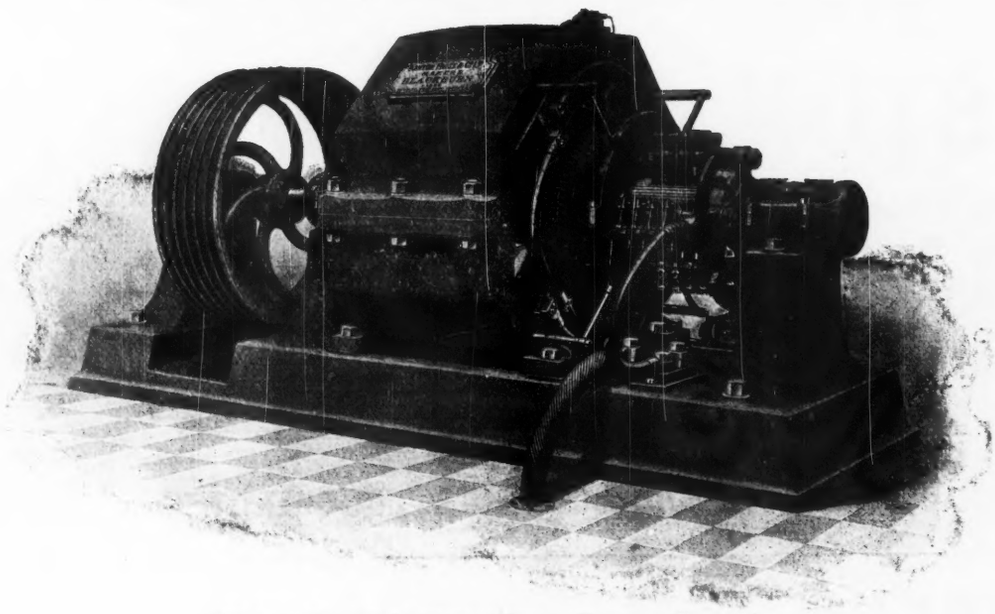

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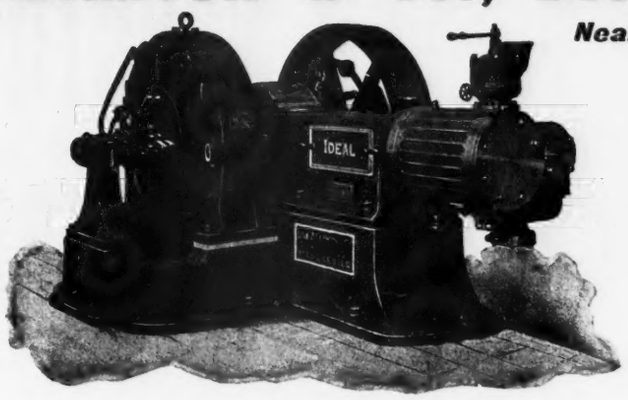

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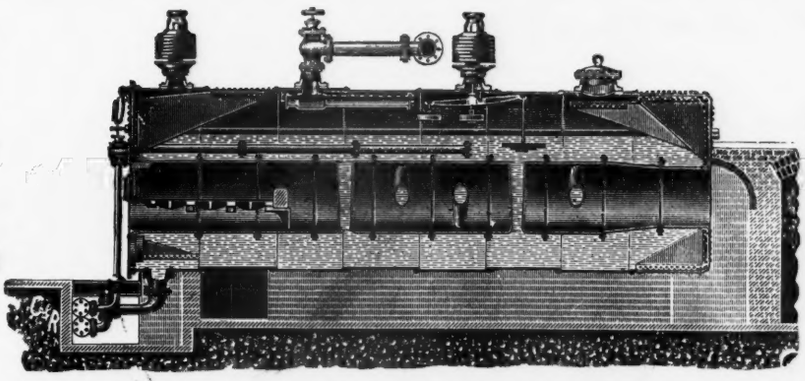

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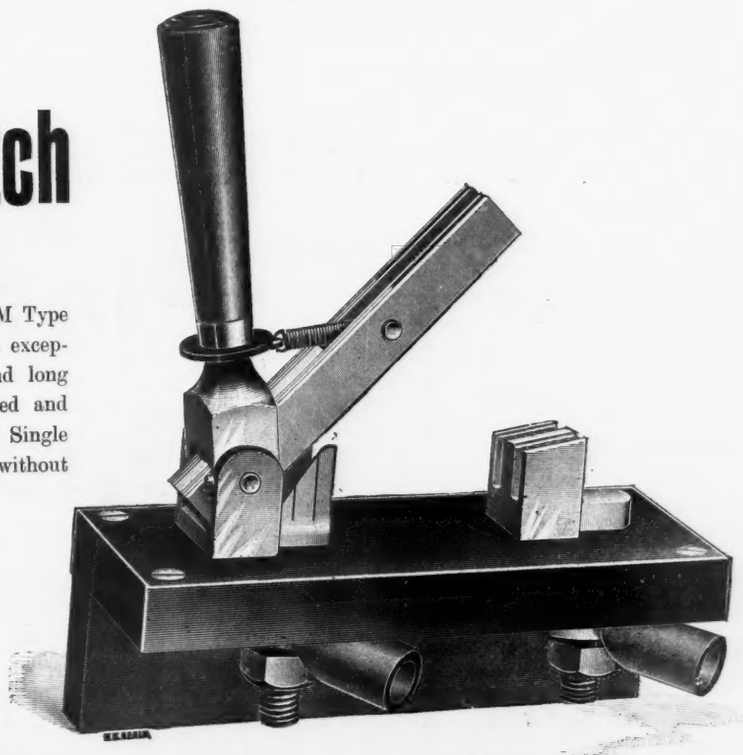

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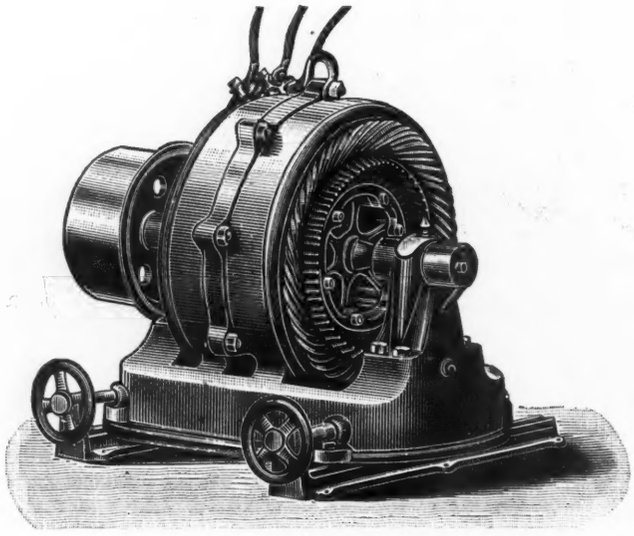

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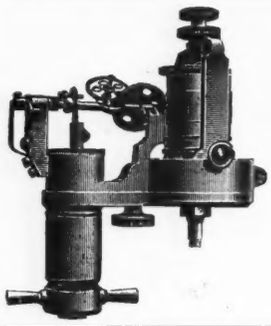

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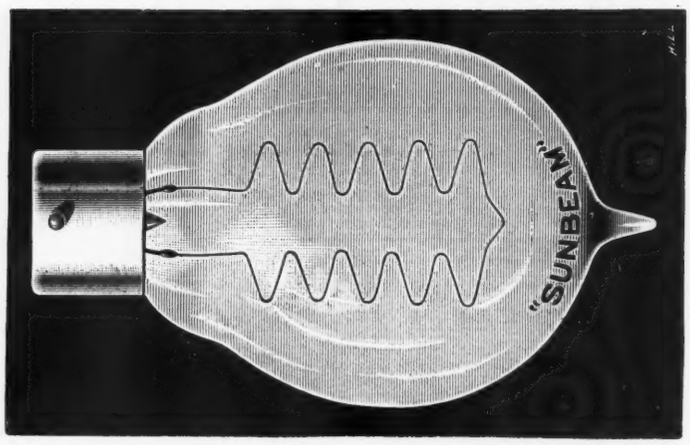

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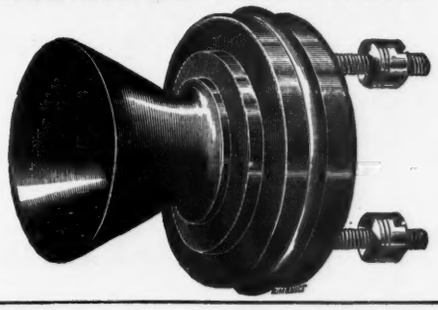

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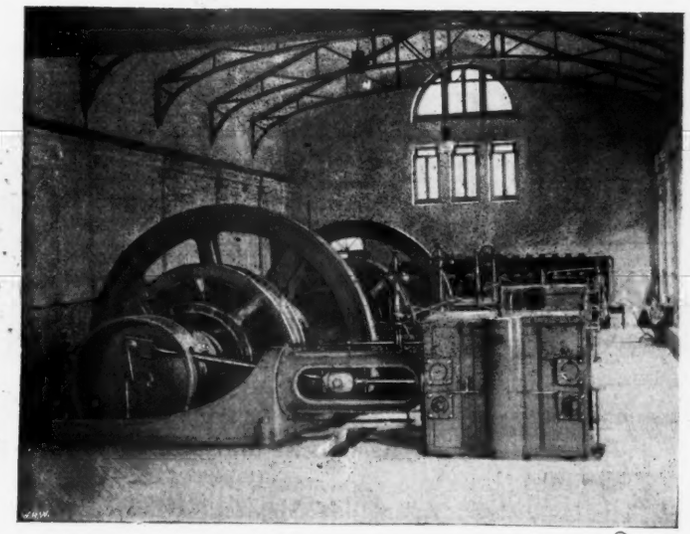

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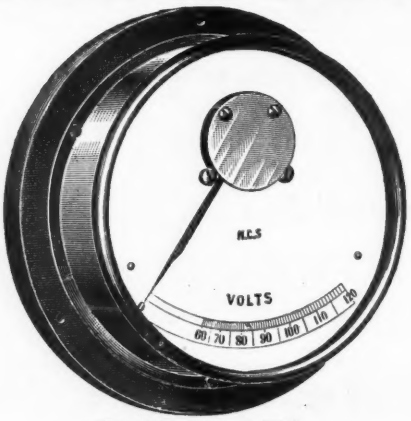

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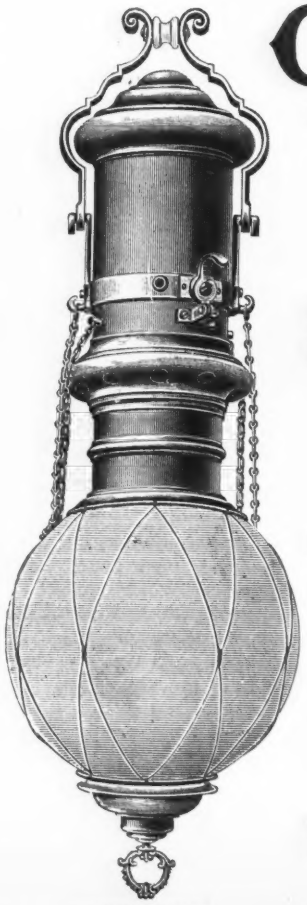

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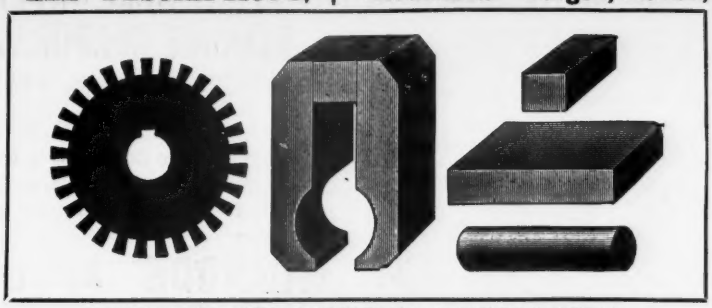

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(Conducted under the auspices of the *Electrical Engineer*).

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Educational Notices.

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ENGINEERING, ARCHITECTURE, AND APPLIED SCIENCE DIVISION OF THE FACULTY OF SCIENCE.

Session 1898–1899.

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Educational Notices.—*Continued.*

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Official Notices.

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34, NEWINGTON GREEN, N.

FIRMS willing to tender for installation of
ELECTRIC LIGHT
on above premises are invited to apply to the Secretary on or before DECEMBER 31st for a copy of Specification.

All firms tendering must be willing to submit to the following

CONDITIONS:

(*a.*) All labour employed to be paid at the rate recognised by the Trade Unions in the district in which the club is situated.

(*b.*) Work to be finished within three months of acceptance of contract.

(*c.*) Estimates to be submitted free.

(*d.*) Terms of payment to be as follows: 50 per cent. on completion of work, 25 per cent. at 3 months. Remainder at 12 months.

(*e.*) Contractors to guarantee, maintain and repair any defect (fair wear and tear excepted) for 12 months, at their expense, and to submit plan of building required for engine and storage.

The Committee of the Club do not bind themselves to accept the lowest, or any, tender.

RALPH MANLEY,
Secretary. 4804

[*Continued on next Page.*]

A handsome and well-finished Cover, suitable for inside

Official Notices.—*Continued.*

GLASGOW CORPORATION.

Electricity Department.

THE GLASGOW CORPORATION invite Tenders for providing and erecting Generating Plant at one or other of their new electricity works. Tenders will include Two Engines of 200, Two Engines of 400, Three Engines of 1,100, and Two Engines of 2,200 indicated horse-power, with Dynamos and Condensing Plant.

Copies of the Specification and Form of Tender may be had on application to Mr. W. A. Chamen, Engineer, 75, Waterloo Street, on payment of Two Guineas, which will be returned on receipt of a *bonâ fide* offer. Tenders, endorsed "Offer for Electricity Generating Plant," to be lodged with the subscriber on or before TUESDAY, JANUARY 21st, 1899.

The Corporation do not bind themselves to accept the lowest or any offer.

J. D. MARWICK,
Town Clerk.

City Chambers, Glasgow,
December 13th, 1898. 4298

TO ELECTRICAL ENGINEERS, CONTRACTORS, and OTHERS.

THE London County Council is prepared to receive tenders for the manufacture, delivery, and erection complete, of four continuous-current dynamos, one motor-generator, two switch-boards with switches, measuring instruments, and other work, required for the proposed Victoria Embankment electric lighting station in the parish of St. Martin-in-the-Fields.

Any person desiring to submit a tender may, on and after Wednesday, January 4th, 1899, inspect the drawings and obtain the specifications, form of tender, and other particulars on application at the Engineer's Department, County Hall, Spring Gardens, S.W., and upon payment of the sum of £2. This amount will, after the Council, or its Committee, shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bonâ fide* tender and not have withdrawn the same. Tenders must be upon the official forms, and the printed instructions contained therein must be strictly complied with. The contractor will be bound by the contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by him wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will, by way of schedule, be inserted in and form part of the contract. Tenders are to be delivered at the County Hall in sealed covers addressed to "The Clerk of the London County Council, County Hall, Spring Gardens, London, S.W.," and marked on the outside, "Tender for dynamos, &c., Victoria Embankment."

No tender will be received after 10 o'clock a.m. on Tuesday, January 31st, 1899. Any tender which does not comply with the printed instructions for tender may be rejected.

The Council does not bind itself to accept the lowest or any tender, and it will not accept the tender of any person or firm who shall on any previous occasion have withdrawn a tender after the same was opened, unless the reasons for the withdrawal were satisfactory to the Council.

C. J. STEWART,
Clerk of the Council.

Spring Gardens, S.W.
December 30th, 1898. 4337

HOW TO MAKE AN ELECTRIC MOTOR.

By EDWARD TREVERT.

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See Illustrated Advertisement last and next weeks. 2062

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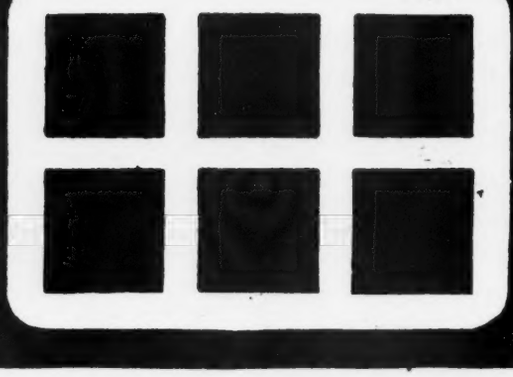

THE

CHLORIDE

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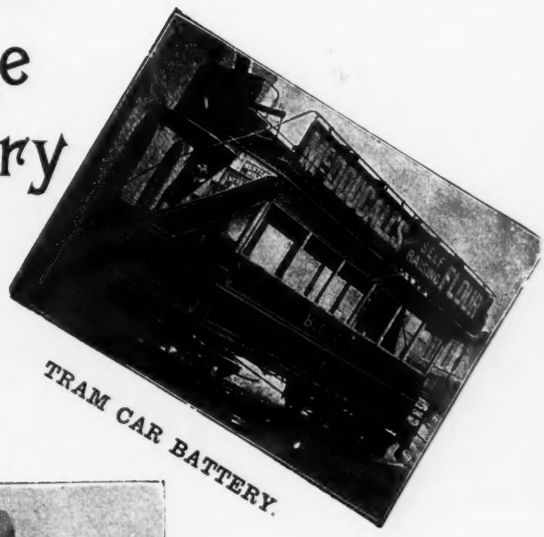
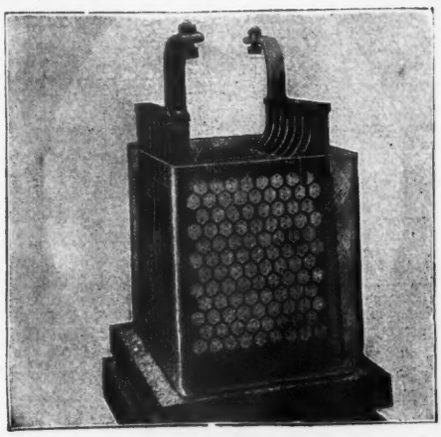


TRAM CAR BATTERY.

AS ADOPTED BY

36

LIGHT AND POWER STATIONS IN THE UNITED KINGDOM.



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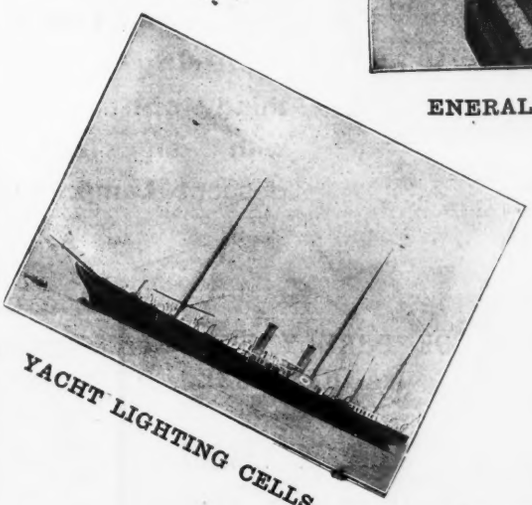

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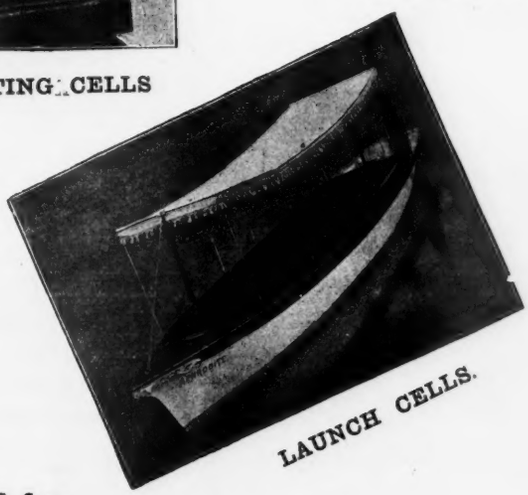

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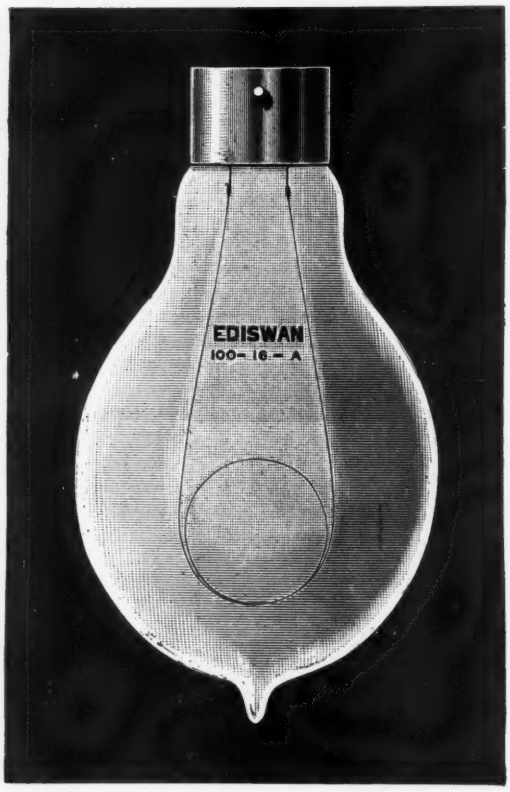

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The Company is the only Firm in the United Kingdom wholly manufacturing everything connected with an Incandescent Lamp.

ACCURATELY MARKED.

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EQUALITY OF LIGHT
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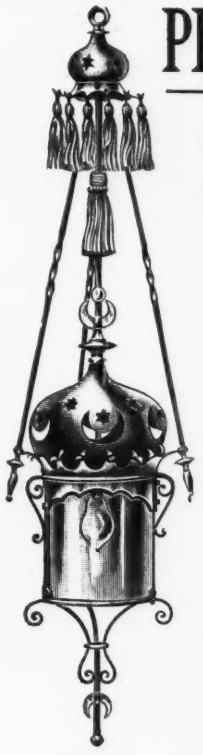

Fig. 3825.

Fig. 3853.

Fig. 3801.

SALE and SHOWROOMS:

HULL:— 1, Grosvenor Buildings, Carr Lane.
LEEDS:— 127, Albion Street.
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- Peel Works, Adelphi, SALFORD.
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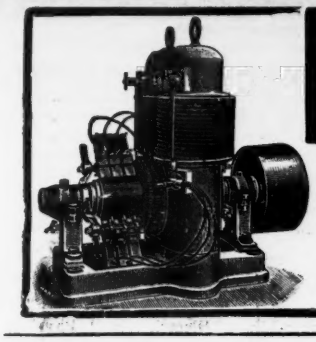

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PUBLISHED EVERY FRIDAY, PRICE 4d.

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To be obtained by order from any Newsagent in Town or Country.

NOTICE TO ADVERTISERS.

The following are the LATEST times up to which Advertisements can be received for publication in current week's issue:—

New Advertisements, or Alterations to existing ones, Wednesday 2 p.m
Small Announcements for middle pages, Thursday 2 p.m.

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Electrical Auctioneers, Valuers,

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Three consecutive Insertions for the Price for Two.

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Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

Original Testimonials should never be sent.

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Electricity Works.

THE CORPORATION are prepared to receive applications for the position of Switchboard Attendant at a commencing salary of £62 per annum. Preference will be given to applicants who have had previous experience of accumulators and of a high tension alternating station.

Applications, endorsed "Switchboard Attendant," detailing experience, and accompanied by copies of not more than three testimonials, should be sent to me not later than TUESDAY, JANUARY 3rd next.

GEO. WM. BAILEY,
Town Clerk.

Town Hall, Eccles,
December 23rd, 1898. 4324

URBAN DISTRICT COUNCIL OF ST. ANNES-ON-THE-SEA, LANCASHIRE.

THE COUNCIL invite applications for the appointment of an Electrical Engineer to design and superintend the erection of an Electric Lighting Station and the laying of Electric Mains, and afterwards to take charge of the Station. Applicants should be experienced in central station work and in mechanical and electrical engineering.

Salary to commence at £170 a year, to be advanced to £200 as soon as the undertaking does not require assistance from the rates, and afterwards proportionately to its success.

Applications endorsed "Electrical Engineer," stating age and previous experience, with copies of testimonials, to be forwarded to the undersigned not later than 5 p.m., January 2nd, 1899.

Canvassing the members either directly or indirectly will be deemed a disqualification.

By Order,
THOMAS BRADLEY,
Clerk to the Council. 4296

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Large Stock kept of SHEETS, RODS, TUBES, ACCUMULATOR BOXES, &c.

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Vulcanite.

SITUATIONS VACANT.—*Continued.*

NORTHAMPTON INSTITUTE, CLERKENWELL, E.C.

APPLICATIONS are invited for the post of EVENING INSTRUCTOR in ELECTRIC WIRING. Candidates should have had experience in all classes of Electric Light Telegraph and Telephone Jointing and Wiring. Time at present required one evening per week. Applications should be received not later than January 3rd. For further particulars apply by letter to

R. MULLINEUX WALMSLEY, D.Sc.,
Principal. 4316

ARMATURE Winders.—Permanent employment is offered to several first-class hands who are well used to plain and slotted drums.—Apply, stating salary required, 4335, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4335

ASSISTANT Storekeeper wanted in London, commencing wages 45s. Qualifications, thorough practical knowledge of electric light stores and parts, and of engineer's and carpenter's tools; good penmanship; quickness at figures and accounts; with experience in directing packers. Age not to exceed 33 years.—Apply, 4322, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4322

WANTED, Armature Winder (age about 30) used to winding Brush arc lighters. Permanent engagement if services satisfactory.—Experience and references to 4268, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4268

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WANTED, in Yorkshire, Armature Winders, thoroughly competent to wind all kinds; permanent work to satisfactory workmen.—4168, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4168

WANTED, Works Assistants, electric light switches and similar fittings, Manchester. Fair draughtsmen.—State experience, salary, &c.—4307, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4307

WIREMAN Wanted, well up in electric light, bells, and telephones; only first-class men need apply with references and particulars. — ALFRED J. HARRISON, A.M.I.E.E., Electrical Engineer, 4, The Broadway, Wimbledon. 4341

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ACTIVE, intelligent, handy man requires Situation; used to driving small hauling engines, stoking Galloway boilers; can turn hands to almost anything.—4343, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4343

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(Continued on next page.)

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ELECTRICAL Engineer, A.I.E.E., desires re-engagement; 12 years' experience, central station designing, erecting plants, power work, estimating; excellent testimonials.—Apply, 4282, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 4282

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HOUSE Wireman wants work, own casing.—PHILLPOT, 13, Millbrook Road, Brixton. 4340

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TO BE SOLD as a going concern or in lots to suit purchasers, the whole of the plant, machinery, and stock at the above premises.

DRIVING POWER consists of vertical boiler and new Marshall's 9 × 12 engine.

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One plating dynamo, 8 volts, 100 amperes.
One lighting dynamo, 60 volts, 50 amperes.
Three nickel-plating tanks.
One copper depositing tank.
One silver depositing tank.
With all the requisite dipping, striking, and scouring tanks.

POLISHING DEPARTMENT contains double ended polishing lathe, roller polishing lathe, scratch brush lathe.
Slide lathe 14 ft. bed, 12 in. centre.
Lacquering table with shelf and burners.

The plant is being used for the purpose of depositing copper on iron shells for calico printing, also for nickel plating engraved rollers up to 72" long × 18" diameter.

All classes of nickel plating, silvering and gilding for the trade is carried on including bicycle fittings.

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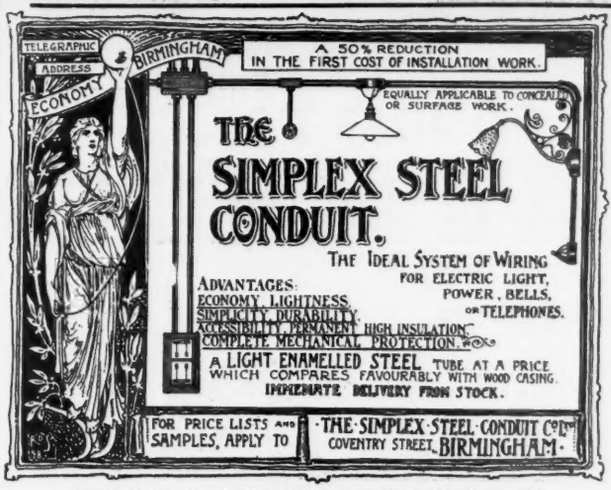
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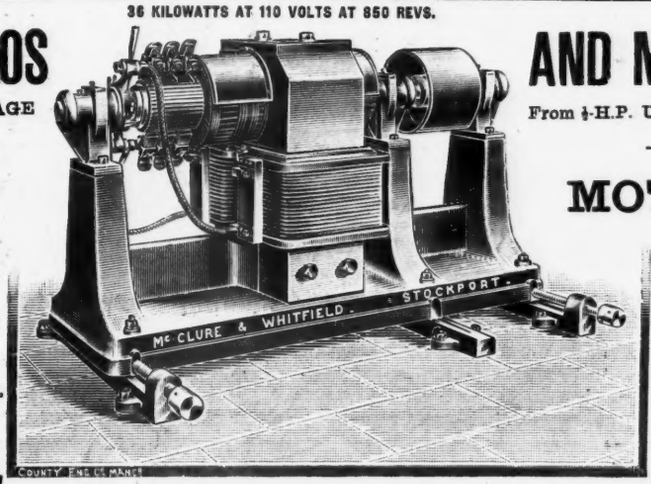

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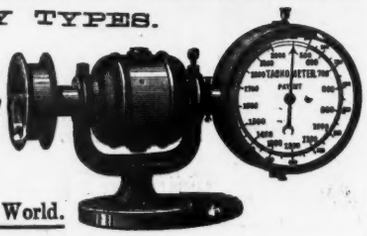

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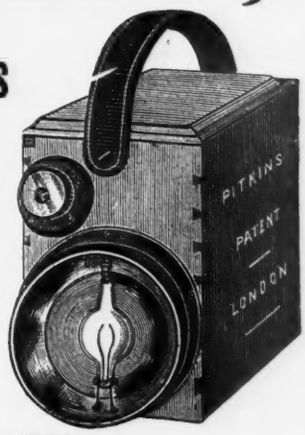

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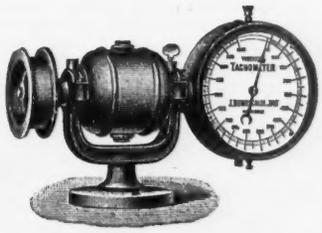

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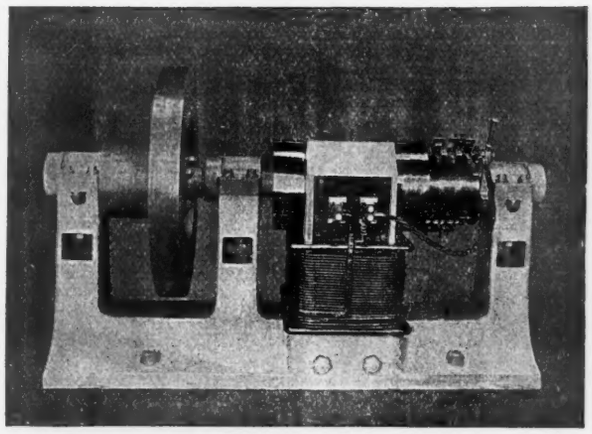

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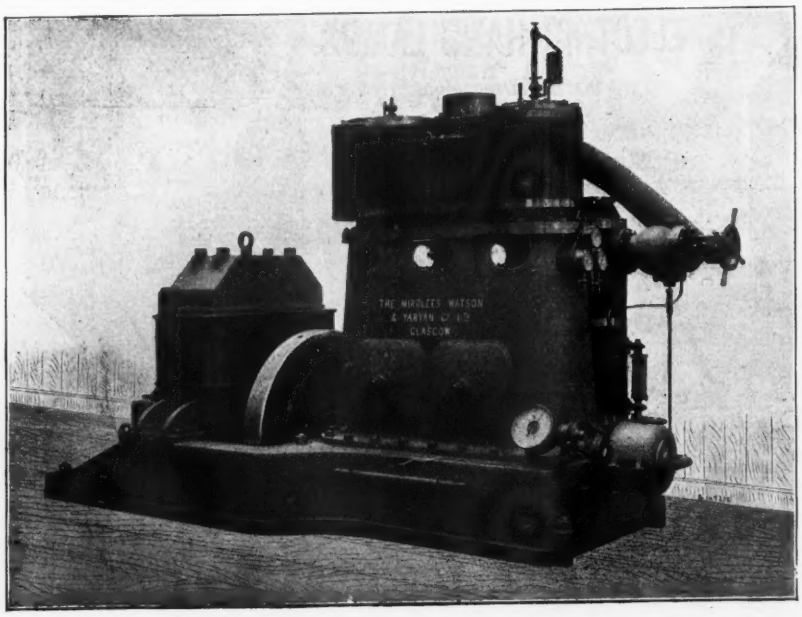

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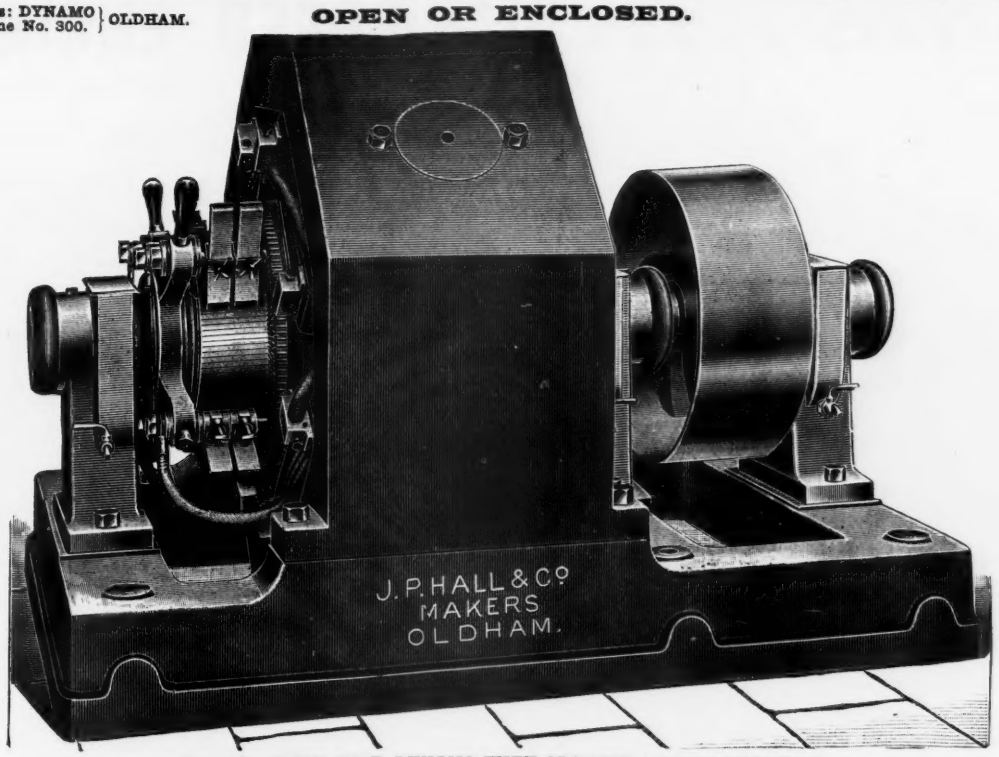

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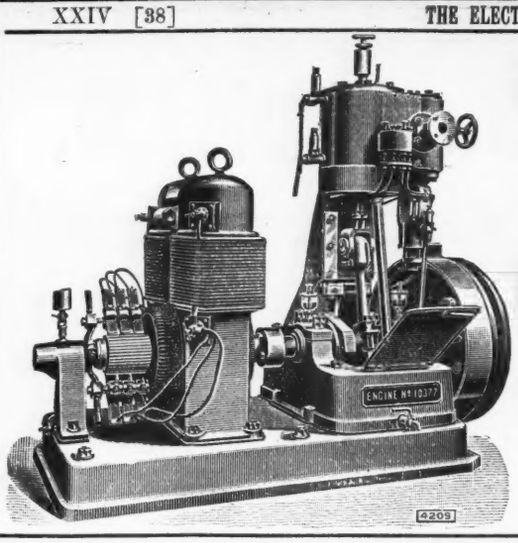

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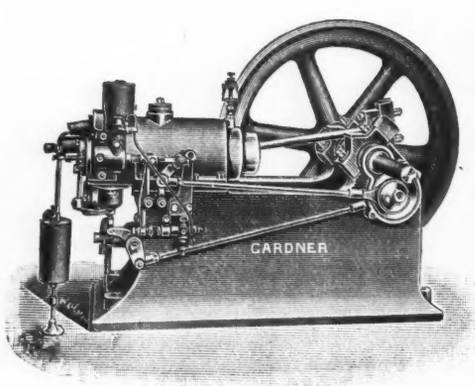

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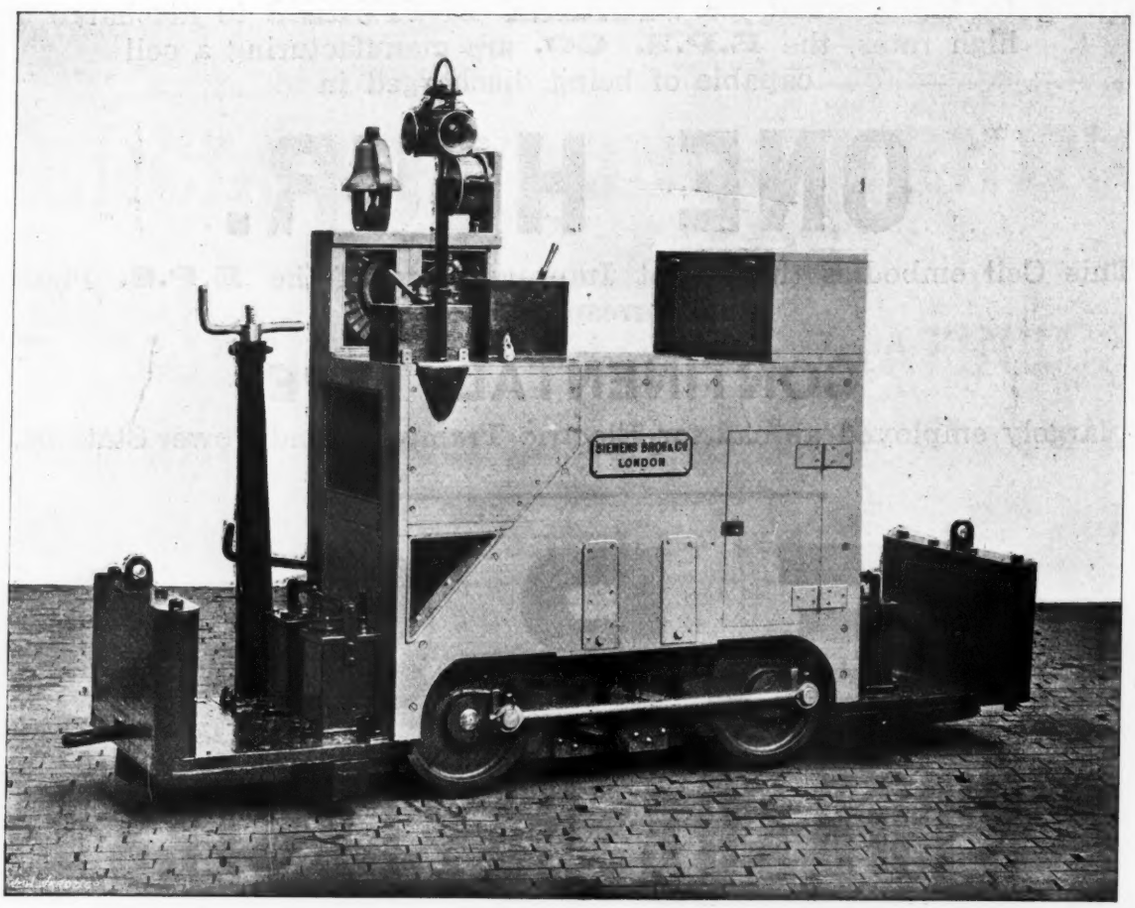

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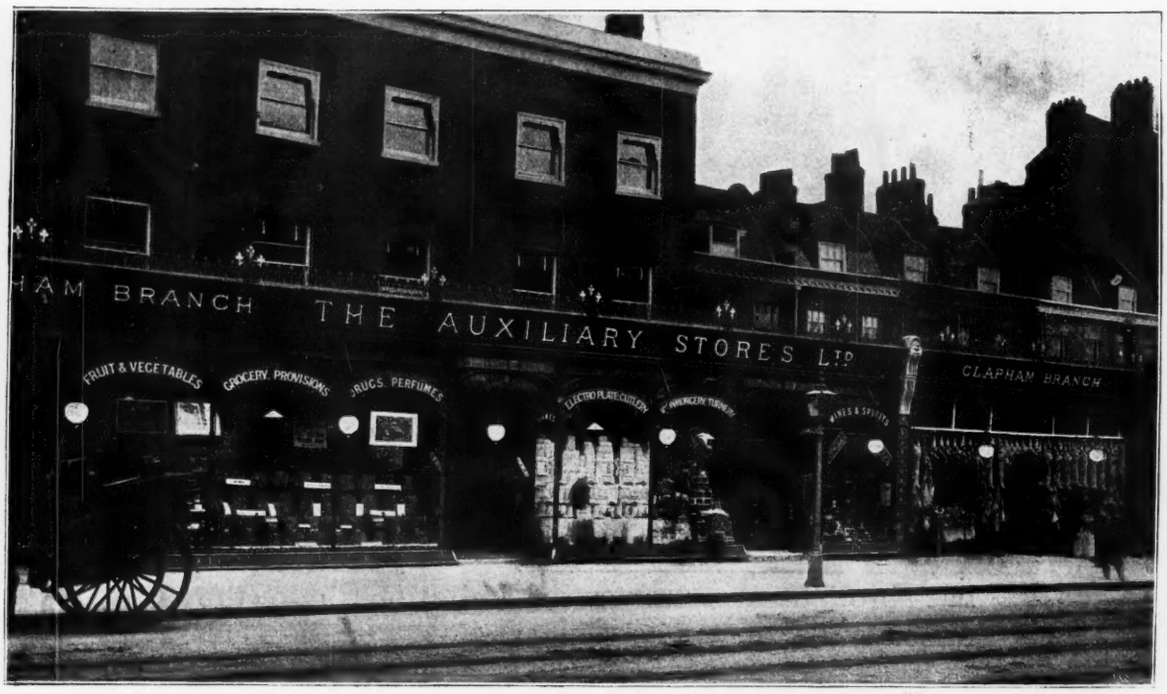

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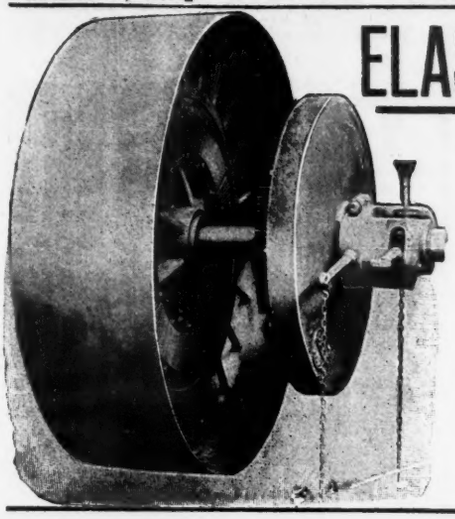

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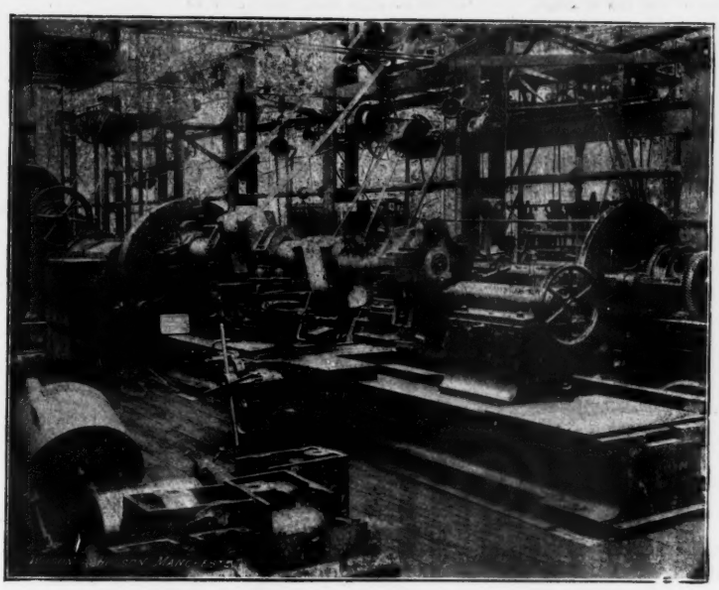

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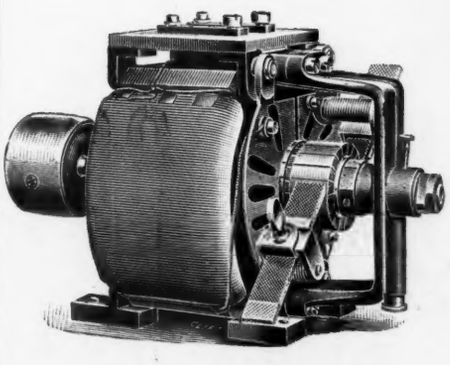

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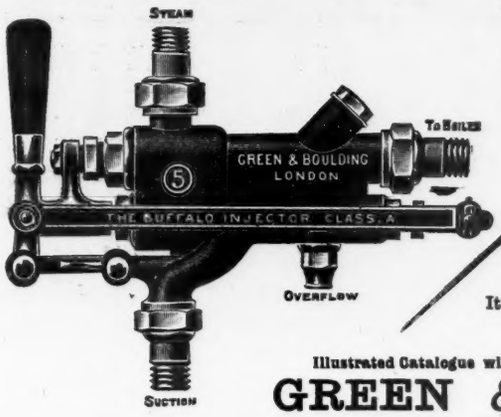

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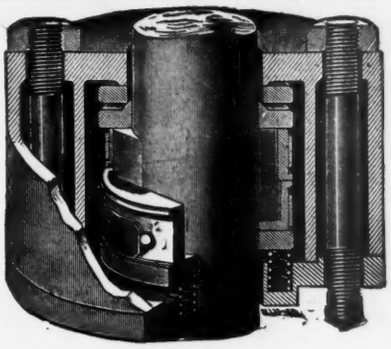

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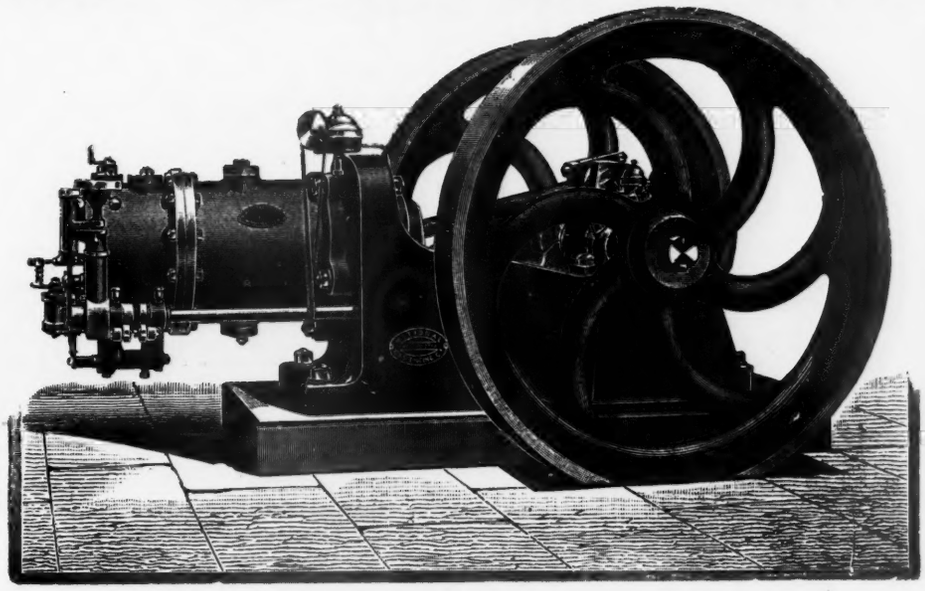

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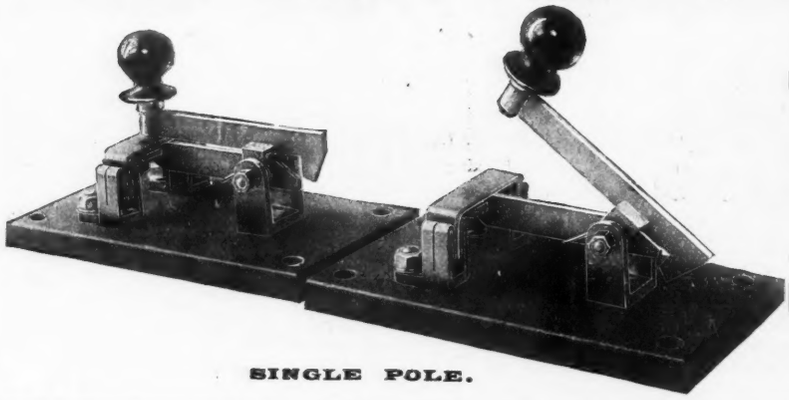

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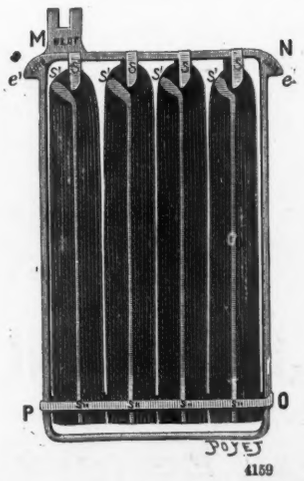

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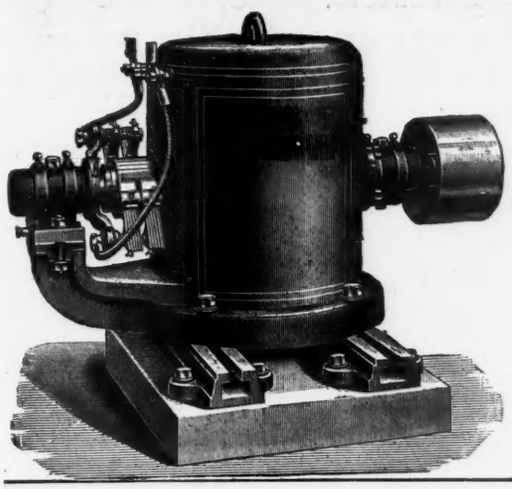

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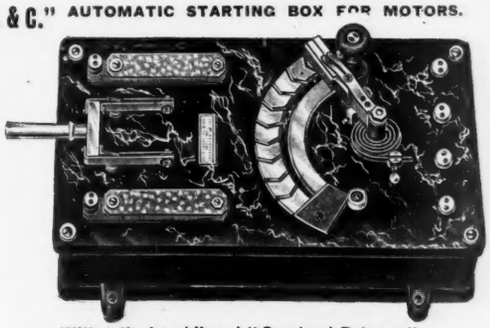

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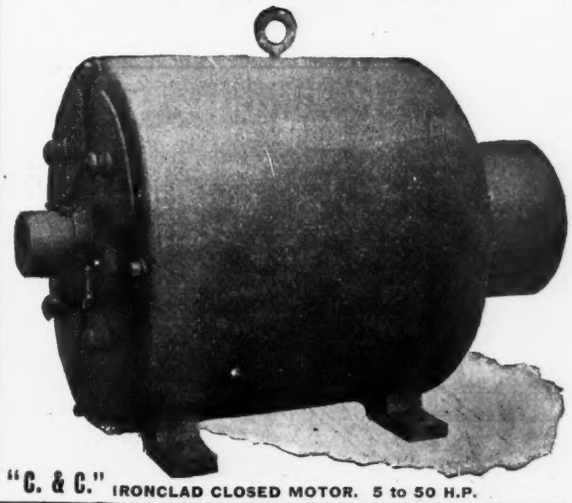

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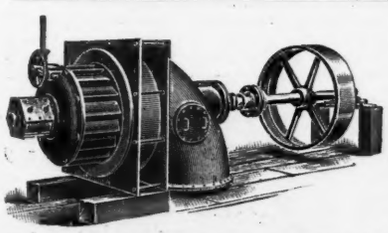

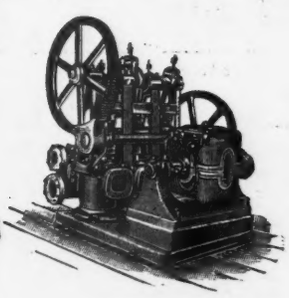

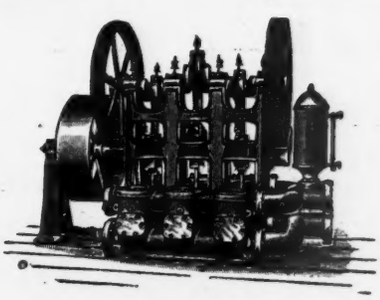

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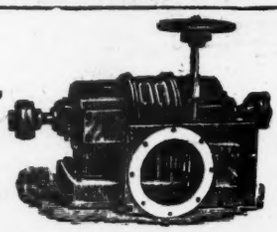

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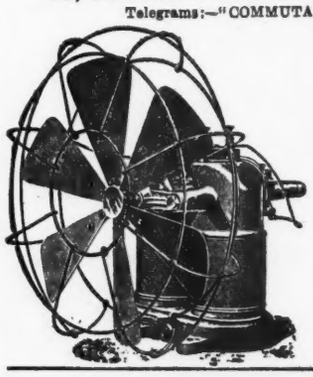

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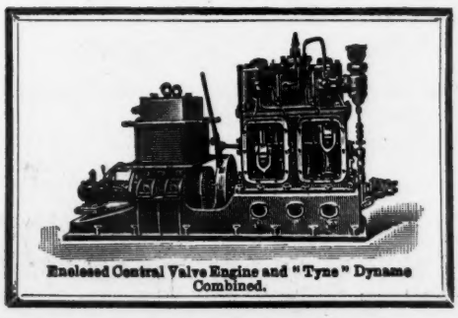

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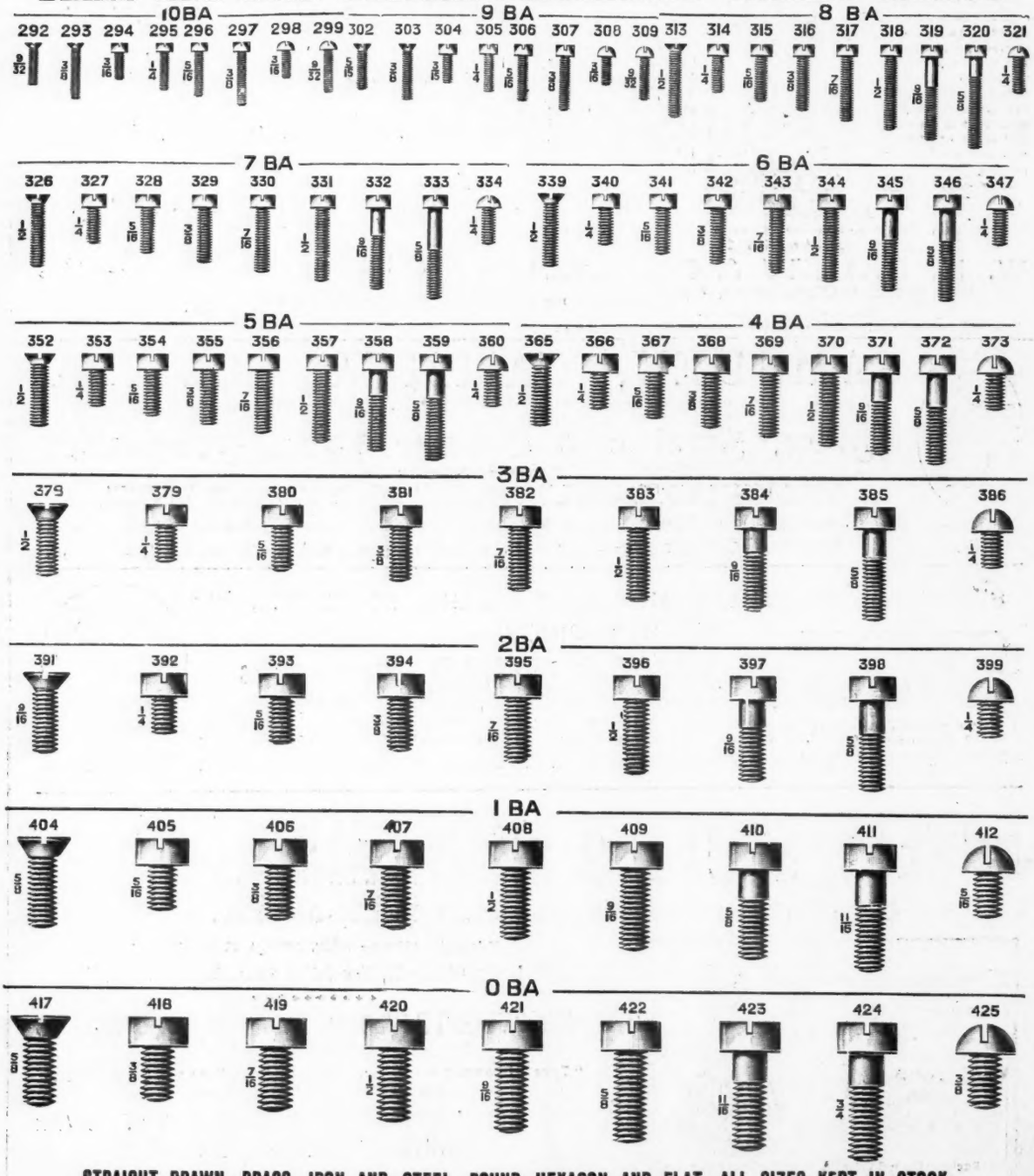

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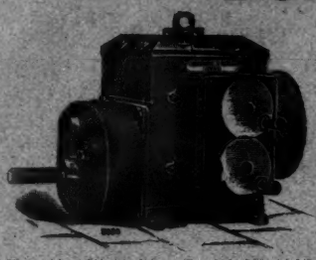

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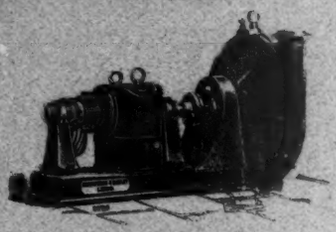

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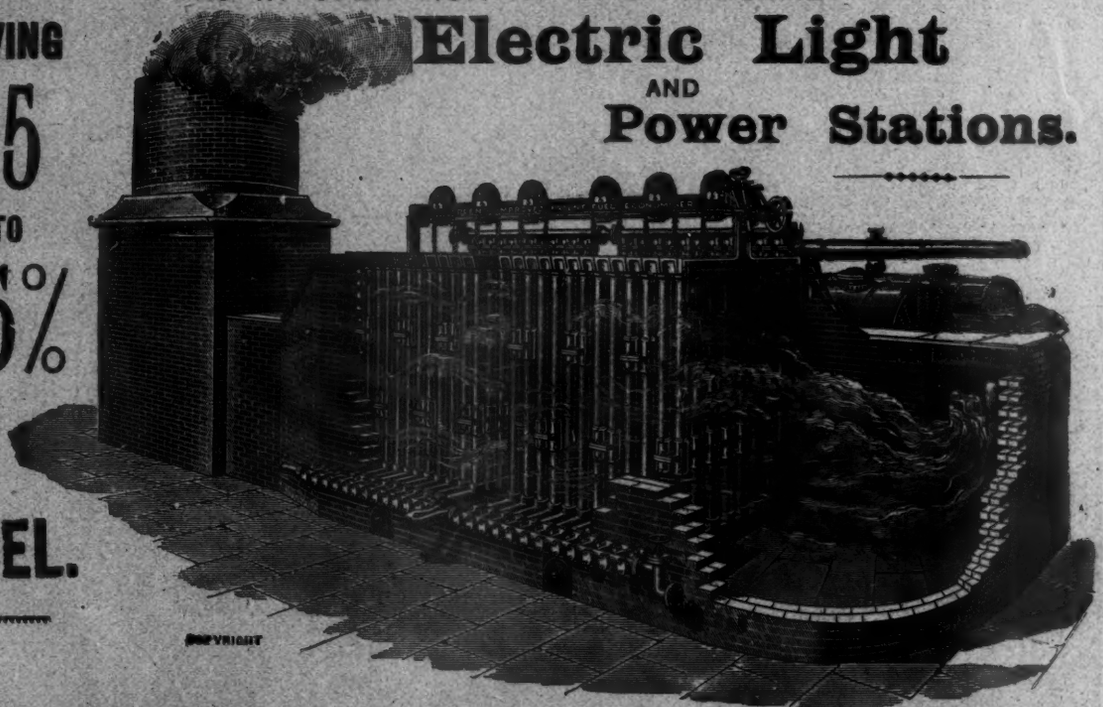

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